R6000-5.6

COMMITTEE ON
POPULATION AND DEMOGRAPHY

Report No. 6

Collecting Data for the Estimation of Fertility and Mortality

Panel on Data Collection
Committee on Population and Demography
Assembly of Behavioral and Social Sciences
National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1981

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

Library of Congress Catalog Card Number 81-86337

International Standard Book Number 0-309-03233-4

Available from

National Academy Press
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Printed in the United States of America

PANEL ON DATA COLLECTION

WILLIAM SELTZER (Chair), Statistical Office, United Nations, New York
LESLIE KISH, Institute for Social Research, University of Michigan
FORREST E. LINDER, International Institute for Vital Registration and Statistics, Bethesda, Maryland
SAMUEL H. PRESTON, Population Studies Center, University of Pennsylvania
CHRISTOPHER SCOTT, World Fertility Survey, London
CONRAD TAEUBER, Kennedy Institute, Center for Population Research, Georgetown University
JACQUES VALLIN, Institut National d'Etudes Demographiques, Paris
H. BRADLEY WELLS, Population Laboratories, University of North Carolina (currently, Oncology Research Center, Bowman Grey School of Medicine)

ROBERT J. LAPHAM, Study Director
JANE E. DURCH, Research Assistant

COMMITTEE ON POPULATION AND DEMOGRAPHY

ANSLEY J. COALE (Chair), Office of Population Research, Princeton University
WILLIAM BRASS, Center for Population Studies, London School of Hygiene and Tropical Medicine
LEE-JAY CHO, East-West Population Institute, East-West Center, Honolulu
RONALD FREEDMAN, Population Studies Center, University of Michigan
NATHAN KAYFITZ, Department of Sociology, Harvard University
LESLIE KISH, Institute for Social Research, University of Michigan
W. PARKER MAULDIN, Population Division, The Rockefeller Foundation, New York
JANE MENKEN, Office of Population Research, Princeton University
SAMUEL PRESTON, Population Studies Center, University of Pennsylvania
WILLIAM SELTZER, Statistical Office, United Nations, New York
CONRAD TAEUBER, Kennedy Institute, Center for Population Research, Georgetown University
ETIENNE VAN DE WALLE, Population Studies Center, University of Pennsylvania

ROBERT J. LAPHAM, Study Director

NOTE: Members of the Committee and its panels and working groups participated in this project in their individual capacities; the listing of their organizational affiliation is for identification purposes only, and the views and designations used in this report are not necessarily those of the organizations mentioned.

Contents

LIST OF TABLES ix

FREQUENTLY USED ABBREVIATIONS IN TABLES xii

LIST OF FIGURES xiii

PREFACE xv

1 OVERVIEW 1

- 1.1 Introduction 1
- 1.2 User Needs 2
- 1.3 The Context of Data Collection 6
- 1.4 Accounting for Errors in Data 8
- 1.5 Comparative Advantages of Data Collection Methods 12
- 1.6 The Essential Complementarity of Data Sources 18
- 1.7 Long vs. Short Planning Horizons 24
- 1.8 Costs of Data Collection 27
  - 1.8.1 Comparative Costs of Different Collection Methods 27
  - 1.8.2 Accounting for Costs of Different Elements of the Process 28
  - 1.8.3 Cost Allocation and Budgetary Practices 31
  - 1.8.4 The Prospects for Improved Cost Analysis 33
  - 1.8.5 Cost Efficiency of Long-Range Planning and Funding Support 35
- 1.9 Summary 42
- References 46

2 THE CENSUS OF POPULATION 49

- 2.1 Introduction 49
- 2.2 Definitions and Background 49
- 2.3 Procedures and Problems in Census Taking 51
- 2.4 Advantages and Limitations 54
- 2.5 Relationships Between Censuses and Sampling 56
  - 2.5.1 Samples Built into Censuses 57
  - 2.5.2 Samples Added to Censuses 60
  - 2.5.3 Sampling from Census Data 61
  - 2.5.4 Using Census Data for Samples 62
- 2.6 The Status of Censuses in Developing Nations 62
  - 2.6.1 Availability of Census Data on Fertility and Mortality 78
  - 2.6.2 Delays in Availability of Census Data 79
- 2.7 Measuring Error in Census Data 98
  - 2.7.1 Estimating Completeness of Coverage 100
  - 2.7.2 Imputation 100
  - 2.7.3 Assessing the Accuracy of Age Reporting 103
- 2.8 Census Questions Related to Fertility 106
- 2.9 Census Questions Related to Mortality 117
- 2.10 Design Issues and Options 118
- 2.11 Summary 122
- References 124

3 THE CIVIL REGISTRATION AND VITAL STATISTICS SYSTEM 129

- 3.1 Introduction 129
- 3.2 Definitions and Background 130
  - 3.2.1 The Special Case of Population Registers 131

3.3 Advantages 132

- 3.3.1 History and Legal Rationale 132
- 3.3.2 The Personal Value of Civil Registration Documents 136
- 3.3.3 Geographic Coverage, Timeliness, and Accuracy 137
- 3.3.4 Administrative and Cost Advantages 138

3.4 Limitations 139

- 3.4.1 Level of Incompleteness 139
- 3.4.2 Dependence on Other Data Sources for Denominator Data 140
- 3.4.3 The Need for Well-Organized Reporting Networks 141
- 3.4.4 Scope of Coverage of Related Variables 143

3.5 Current Status of CR/VS Systems 146

- 3.5.1 Organizational Differences Among Countries 146
- 3.5.2 Dispersal of Responsibility Within a Country 148
- 3.5.3 Availability and Quality of Data 150
- 3.5.4 Other Aspects of Data Quality 158

3.6 Attempts at Improvement 165

- 3.6.1 Use of Indirect Estimation Methods 171
- 3.6.2 The Tabulation Area Approach 172
- 3.6.3 The Sample Registration Approach 175
- 3.6.4 Coordination 178
- 3.6.5 Logistical Improvements 179
- 3.6.6 Personnel Improvements 180
- 3.6.7 Public Education 180
- 3.6.8 Improvements in Tabulation 181

3.7 Summary 181
References 183

4 SURVEYS 187

4.1 Introduction 187
4.2 Background 189
4.3 Definitions 191

    4.3.1 Single-Round Demographic Surveys 193
    4.3.2 Multi-Round Surveys 194
    4.3.3 Dual-Record Systems 196
    4.3.4 Fertility Surveys 198

4.4 General Characteristics and Problems of Surveys 200

    4.4.1 Type and Scope of Information Needed 200
    4.4.2 Advance Planning of Survey Operations 201
    4.4.3 General Design Considerations 201
    4.4.4 Effects of Sample Design on Error 208
    4.4.5 Coverage Errors and Biases 216
    4.4.6 Response Errors and Biases 219
    4.4.7 Adjusting Data to Correct for Errors 231
    4.4.8 Other Important Considerations in Surveys 232

4.5 Advantages and Disadvantages of the Four Types of Surveys 233

    4.5.1 Single-Round Surveys 233
    4.5.2 Multi-Round Surveys 235
    4.5.3 Dual-Record Systems 237
    4.5.4 Fertility Surveys 239

4.6 How Good Are Survey Estimates? 243
4.7 The Extent to Which Surveys Are Used in Estimating Fertility and Mortality 250
4.8 Summary 254
References 261

APPENDIX A CALCULATING TOTAL ERROR IN FERTILITY AND MORTALITY ESTIMATION 271

APPENDIX B COLLECTING DATA ON RECENT AND CUMULATIVE DEMOGRAPHIC EVENTS 276

GLOSSARY 283

List of Tables

1.1 Illustrative Listing of Detail Frequently Required in the Analysis of Fertility and Mortality Data 4
1.2 Percentage Distribution of Deaths by Age in Selected Developed and Developing Countries 8
1.3 Suitability of Various Techniques for Detecting Births and Deaths, Classified by Data Collection Method 14
1.4 Examples of Approximate Sampling Errors Associated with Estimates of the Crude Birth Rate and the Age-Specific Fertility Rate, by Size of Sample 18
1.5 Intrinsic Characteristics of Data Collection Methods in Providing Data Needed to Estimate Fertility and Mortality: A Comparison Using Seven Criteria 20
1.6 Some Advantages and Limitations of Population Censuses, Civil Registration Systems, and Sample Surveys 22
1.7 Likely Relationship Between the Costs of Data Collection Systems and Specific Determining Factors 36

2.1 Type, Quality, and Availability of Data from Recent Censuses and Status of Census for 1980 Round: 95 Developing Nations with Estimated Mid-1980 Population of 1 Million or More, by Region 64
2.2 Number of Countries Conducting a National Census and Percentage of World and Continental Populations Covered by These Censuses, by Ten-Year Periods from 1945 to 1984 76
2.3 Presence of Retrospective Questions on Fertility and Mortality on Census Schedules in 1960, 1970, and 1980 Census Rounds: 95 Developing Nations with Estimated Mid-1980 Population of 1 Million or more, by Region 80

2.4 Length of Time Between Censuses and International Availability of Provisional and Final Counts and Age-Sex Distribution: 1970 and Later, in Selected Nations in Developing Regions 92
2.5 Measures of Accuracy and Completeness of Censuses in the 1960, 1970, and 1980 Rounds: Selected Developing Countries by Region 101
2.6 Number of Countries Including Fertility and Mortality Questions in Their Census Schedules and the Availability of Information About Those Questions: 1970 Census Round in Selected Developing Countries, by Region 108
2.7 Techniques for Estimating Fertility and Mortality Using Data Collected from Censuses 110

3.1 Type and Time of Implementation of Civil Registration/Vital Statistics Systems, Classified by Region 135
3.2 United Nations Recommendations for Items to be Included in Civil Registration Records 144
3.3 Sources of Vital Statistics Data: Number of Countries that Obtain Vital Statistics from Civil Registration Systems, Sample Registration Area Systems, and Sample Surveys, Classified by Region and Type of Vital Event 147
3.4 Government Agencies Responsible for Civil Registration and Compilation of Vital Statistics at the National Level: 102 Countries 149
3.5 Reported Levels of Completeness of Birth and Death Registration: Number of Countries Classified by Region, 1961-81, from United Nations Sources 152
3.6 Percentage of World and Region Population Living in Countries for Which Selected Fertility and Mortality Information is Available from CR/VS Systems, Classified by Levels of Completeness of the CR/VS Systems: Circa 1975 154
3.7 Delayed Registration of Vital Events in Costa Rica, Korea, and Japan: Percentage of Births and Deaths Occurring in Years Before the Year of Registration and Mean Number of Years Delay in Registration 160
3.8 Number of Reporting Countries with Specified Requirements for Registration of Live Births and Deaths, Classified by Region 162
3.9 Requirements for Registering Births and Deaths by Place of Occurrence or Place of Residence, Classified by Region 163

3.10 Completeness of Birth Registration and Years for Which Selected Data on Births Are Available, as Reported in U.N. Sources: Selected Countries in Developing Regions 166

4.1 Median Values of roh by Variable Group in WFS Studies in 12 Developing Countries 212
4.2 2-Sigma Confidence Intervals for Estimates of Crude Vital Rates Based on Given Sample Size, Cluster Size, and Ratio of Homogeneity 215
4.3 Ranges of Estimates (Confidence Intervals) Derived for a Crude Birth Rate of 40 as the Sample Size, Cluster Size, and Ratio of Homogeneity Are Varied 216
4.4 Average Number of Children Ever Born per Woman by Age Group, Type of Schedule, and Whether Children are Still Alive or Now Dead: Kenya 222
4.5 Estimates of Total Fertility Rate Derived from Various Data Sources: Colombia 1976 Fertility Survey 226
4.6 Effect of Proxy Reporting on Estimates of Current Fertility: Colombia 1976 National Fertility Survey 229
4.7 Estimated Average Completeness of Birth and Death Rates Reported in Surveys in Asia, 1945-67: Estimates from Selected Single-Round Surveys and Repeated Single-Round Surveys Compared to Dual-Record System Estimates 245
4.8 Comparison of Crude Birth and Death Rates Estimated from Baseline Retrospective Survey and from Subsequent Rounds: Senegal 1970-71 Demographic Survey 246
4.9 Comparisons of CBR and CDR Estimates Based on Selected Data Collection Methods: Kenya 248
4.10 Number of Major Demographic and Fertility Surveys Carried out Since Approximately 1960, Classified By Region and Decade 252
4.11 Number of Major Demographic and Fertility Surveys Carried out in Developing Nations Since Approximately 1960, Classified By Time Periods 1960-69 and 1970-80 254
4.12 Measures of the Time Lag Between Field Work and the Publication of Results, for Specified Dual-System Studies and Other Measurement Procedures 258

B.1 Number of Out-of-Scope Vital Events Reported in Experimental Dual-Record Systems, as Measured by Field Rechecks of Unmatched Survey Events 279

FREQUENTLY USED ABBREVIATIONS IN TABLES

CAPMAS	Central Agency for Public Mobilisation and Statistics (Egypt)
CDC	Cairo Demographic Centre
CELADE	Centro Latinoamericano de Demografia
ECWA	Economic Commission for Western Asia
ESCAP	Economic and Social Commission for Asia and the Pacific
OECD	Organisation for Economic Co-operation and Development
PVSR	United Nations Population and Vital Statistics Report (published quarterly)
UNDY	United Nations Demographic Yearbook (published annually)
UNECA, UNECWA, UNESCAP	United Nations Economic Commissions for Africa, Western Asia, and Asia and the Pacific, respectively. (See also ECWA and ESCAP)
UNSO	United Nations Statistical Office, New York
USBC	U.S. Bureau of the Census, Country Demographic Profiles (various issues)
WP75, WP77, WP 79	U.S. Bureau of the Census, World Population: 1975, World Population: 1977, and World Population: 1979.

List of Figures

2.1 Age Structure of Colombia, 1973 56
2.2 The Purposes Served by Associating Samples with Censuses 58
2.3 Major Design Issues and Options in Conducting a Population Census 118

3.1 U.N. Recommendations Concerning the Use of Tabulation Areas in Civil Registration/Vital Statistics Systems 173

4.1 A Checklist of Major Tasks and Choices Facing Planners and Administrators of Surveys for Collecting Fertility and Mortality Data 202
4.2 Average Number of Children Ever Born Alive by Survival Status at Time of Interview and by Type of Questionnaire: Kenya Baseline Survey, 1973 223
4.3 Average Number of Children Ever Born Alive by Survival Status at Time of Interview and by Type of Questionnaire: Kenya Retrospective Survey, 1975 224

Preface

The Committee on Population and Demography was established in April 1977 by the National Research Council, in response to a request by the Agency for International Development (AID) of the U.S. Department of State. It was widely felt by those concerned that the time was ripe for a detailed review of levels and recent trends of fertility and mortality in the developing world. Although most people in the demographic community agree that mortality has declined in almost all developing countries during the last 30 years, there is uncertainty about more recent changes in mortality in some countries, about current levels of fertility, and about the existence and extent of recent changes in fertility.

In 1963, a Panel on Population Problems of the Committee on Science and Public Policy of the National Academy of Sciences published a report entitled The Growth of World Population. The appointment of that panel and the publication of its report were expressions of the concern then felt by scientists, as well as by other informed persons in many countries, about the implications of population trends. At that time, the most consequential trend was the pronounced and long-continued acceleration in the rate of increase of the population of the world, and especially of the population of the poorer countries. It was estimated in 1963 that the annual rate of increase of the global population had reached 2 percent, a rate that, if continued, would cause the total to double every 35 years. The disproportionate contribution of low-income areas to that acceleration was caused by rapid declines in mortality combined with high fertility that remained almost unchanged: the birth rate was nearly fixed or declined more modestly than the death rate.

Since the earlier report, however, the peak rate of growth in the world's population has apparently been passed. A dramatic decline in the birth rate in almost all the more developed countries has lowered their aggregate annual rate of increase to well below 1 percent, and the peak rate of increase has also apparently been passed in the less-developed parts of the world as a whole. A sharp decline in fertility in many low-income areas has more than offset the generally continued reduction in the death rate, although the rate of population increase remains high in almost all less developed countries.

The causes of the reductions in fertility--whether they are the effect primarily of such general changes as lowered infant mortality, increasing education, urban rather than rural residence, and improving status of women, or of such particular changes as spreading knowledge of and access to efficient methods of contraception or abortion--are strongly debated. There are also divergent views of the appropriate national and international policies on population in the face of these changing trends. The differences in opinion extend to different beliefs and assertions about what the population trends really are in many of the less-developed countries. Because births and deaths are recorded very incompletely in much of Africa, Asia, and Latin America, levels and trends of fertility and mortality must be estimated, and disagreement has arisen in some instances about the most reliable estimates of those levels and trends.

It was to examine these questions that the Committee on Population and Demography was established within the Assembly of Behavioral and Social Sciences of the National Research Council. It was funded initially for a period of three years by AID under Contract No. AID/pha-C-1161. The Committee has undertaken three major tasks:

1. To evaluate available evidence and prepare estimates of levels and trends of fertility and mortality in selected developing nations;
2. To improve the technologies for estimating fertility and mortality when only incomplete or inadequate data exist (including techniques of data collection);
3. To evaluate the factors determining the changes in birth rates in less-developed nations.

Given the magnitude of these tasks, the Committee decided to concentrate its initial efforts on the first two tasks; it initiated work on the third task in 1979.

The Committee approaches the first task through careful assessment, by internal and external comparison, and through analysis, by application of the most reliable methods known, of all the data sources available. Each of the country studies therefore consists of the application of a range of methods to a number of data sets. Estimates of levels and recent trends judged to be the best that are feasible with available resources are then developed on the grounds of their consistency and plausibility and the robustness of the individual methods from which they were derived.

The Committee's second task, refinement of methodology, is seen as a by-product of achieving the first. The application of particular methods to many different data sets from different countries and referring to different time periods will inevitably provide valuable information about the practical functioning of the methods themselves. Particular data sets might also require the development of new methodology or the refinement of existing techniques.

The Committee set three criteria for identifying countries to study in detail: that the country have a population large enough to be important in a world view; that there be some uncertainty about levels and recent trends of fertility and mortality; and that sufficient demographic data be available to warrant a detailed study. After a country has been selected for detailed study, the usual procedure is to set up a panel or working group of experts, both nationals of the country and others knowledgeable about the demography and demographic statistics of the country. The role of these panels and working groups, which generally include at least one Committee member, is to carry out the comparisons and analyses required. A small staff assists the Committee, panels, and working groups in their work.

As of late 1981, 168 population specialists, including 94 from developing countries, have been involved in the work of the Committee as members of panels or working groups. The Committee, the Assembly, and the National Research Council are grateful for the unpaid time and effort these experts have been willing to give.

Each country being studied has a different mix of data sources and different problems with data errors.

Therefore, there is no standard pattern for all the reports. However, each report includes a summary of the main findings regarding estimates of fertility and mortality, a description of the data sources available, and a presentation of the analyses that were carried out, classified by type of data analyzed; detailed methodological descriptions are included where necessary in appendixes.

As part of the second major task and given the importance of data collection in estimating fertility and mortality, the Committee established the Panel on Data Collection, chaired by William Seltzer, a member of the Committee. The specific objective of the Panel on Data Collection is to assist the Committee on Population and Demography in developing recommendations for improving and standardizing techniques for estimating fertility and mortality levels, trends, and patterns in developing nations. To this end, the panel has focused on methods of improving the accuracy, coverage, timeliness, and reliability of such estimates through improvements in the collection of underlying data. As indicated in this report, the methods may range from improved data collection procedures that can be applied immediately to long-term processes that take many years to bring into fruitful operation.

This report is No. 6 in a series produced by the Committee on Population and Demography of the National Research Council. The second product of the Panel on Data Collection, it reviews experience on collecting data using population censuses, civil registration and vital statistics systems, and sample surveys. It is a state-of-the-art report on available procedures that focuses on questions of special relevance to the estimation of fertility and mortality.

The first Panel report was a study of one of the major problems related to the collection of data for fertility and mortality estimation, that of age misreporting and age-selective underenumeration. The study was prepared by Douglas C. Ewbank and published as Report No. 4 of the Committee on Population and Demography.

This second Panel report is intended to provide detailed guidance and information for people who are concerned about the collection of data for demographic measurement in developing nations. These people include administrators and, especially, technicians and survey practitioners in government and international statistical agencies, teachers and researchers in universities and demographic training centers, policy makers who have to decide on the allocation of funds and personnel for data collection activities, and data users who wish to know more about the difficulties, opportunities, and consequences associated with various data collection processes used to collect fertility and mortality data. Thus the report should be of interest to many persons who determine what data should be collected and by what means, those responsible for collecting and processing the data, and users. However, this report is not intended as a detailed compendium covering all details associated with data collection procedures. For example, complete texts have been written on survey sampling. Therefore, although occasionally there is extended discussion in this report, those discussions include generalizations that must be recognized as oversimplifications. Also, the report is concerned primarily with official data collection procedures, although it is recognized that nongovernment institutions--for example, universities--are very much involved in data collection for research activities.

The Panel on Data Collection has prepared one other report, a brief summary statement for administrators on how to improve data collection processes related to the estimation of fertility and mortality levels and trends. It is published as Report No. 7 of the Committee on Population and Demography.

Special acknowledgment is owed to several persons, in addition to the Panel members and Committee staff listed above, who assisted in the preparation of this report. Carl Haub, a research assistant with the Committee during part of 1978, assisted with the compilation of data and preparation of tables for the census chapter in particular. Mary Anne Fitzgerald and Josephine Floyd, research assistants on the Committee staff during 1978 and 1979, also assisted with the preparation of tables. Typing assistance was provided by Solveig Padilla, Brenda Buchbinder, Benita Anderson, and Lois Hemphill.

The Statistical Office of the United Nations deserves specific thanks for making available to the Panel provisional results from a study, Civil Registration/Vital Statistics: National Practices in 1977. That office also kindly allowed the use of its files on censuses and special tabulations prepared by members of the Office staff.

The committee wishes to thank also the Committee, Assembly, and Report Review Committee reviewers of this

report. Particular thanks are expressed to Henry S. Shryock of Georgetown University for his review of the manuscript. The report has benefitted from the comments of all of these reviewers. Thanks are also offered to Douglas C. Ewbank of the Harvard School of Public Health for his review of an early draft. The report has also been improved by the skill of Katherine Miller, the Committee's editor, and the careful production hand and eyes of Elaine McGarraugh, the Assembly's editorial assistant.

ANSLEY J. COALE
Chair, Committee on
Population and Demography

1 Overview

1.1 INTRODUCTION

The purpose of this report is to review what is known about collecting the data needed to estimate levels and trends in fertility and mortality. Fertility and mortality data are defined broadly as sets of information that enable users to estimate directly or indirectly measures of fertility such as the crude birth rate, age-specific fertility rates, and the net reproduction rate; and measures of mortality such as the crude death rate, life expectancy at different ages, and infant mortality. Although the report focuses on the task of collecting data in developing countries, relevant experience is drawn from all parts of the world.

There are three major methods used to gather fertility and mortality data: the population census, the civil registration or vital registration system, and the sample survey. Each method is described in detail in the chapters that follow. The present chapter deals with issues that affect all data collection efforts, including the different demands made by data users, the importance of efforts to assess the degree of error in data collected, and the questions of advance planning and cost assessment. Most importantly, it stresses the essential complementarity of the three collection methods, by highlighting the relative strengths and weaknesses of each in relation to different needs and situations.

The chapter is organized around six major points. First, users of fertility and mortality data have quite different needs with respect to the detail, timeliness, and accuracy of such data. Second, it is important to understand the components of error in data, and to relate the degree of required accuracy to the expected uses of the estimates derived from the data. Third, the three major methods of data collection are more or less well-defined processes with distinctive although somewhat overlapping performance characteristics in terms of the detail, timeliness, and accuracy of the data they can generate. Fourth, the three major collection methods must be seen as complementary; no one alone can adequately serve all the needs for fertility and mortality data. Fifth, it is important to consider the length of advance planning required for different data collection activities, and to keep this in mind in developing strategies for improving national data collection capabilities. Sixth, the question of the costs of data collection deserves much more attention.

1.2 USER NEEDS

The collection of fertility and mortality data is not an end in itself but a means to an end. Thus, any review of the methods of data collection must consider the range of uses to which the data, once obtained, are put. These varied uses of data, because they often have quite different statistical requirements, necessarily affect the overall strategy of data collection and the methods to be employed at each stage of the collection and estimation process.

In developing countries, data on fertility and mortality are generally used in three main ways: first, as the basis for policy guidance, planning, and projections; second, in monitoring current demographic trends and action programs; and third, to support the scientific study of interrelationships between demographic phenomena and socioeconomic developments at either the micro or macro level. For convenience, we will refer to these three broad categories of use as (1) policy making, (2) administration, and (3) research.

For certain purposes it may be enough to collect data that allow users to determine simply the approximate level or range of fertility or mortality. For example, in deciding whether or not to establish a family-planning program or an infant health-care program, it may be necessary only to be reasonably certain that fertility and infant mortality are "high," that is, above certain levels--such as a crude birth rate of 40 births per 1,000 population and an infant mortality rate of 125 deaths per 1,000 live births. As long as the margins of error in the estimates produced do not extend below these boundaries, the process is adequate to the task at hand. For example, if the collection and estimation process leads to values of 48 for the crude birth rate and 145 for the infant mortality rate, each with margins of error of plus or minus 10 percent, the user can be reasonably certain that the rates are "high" as defined by the standards above. However, other users who require more precise measures of levels might find these same estimates unsatisfactory.

Uses that require only a rough indication of the level of fertility or mortality place minimal demands on the collection process in terms of the detail and accuracy required. However, most data needed for policy making, administration, or research have to meet more extensive and rigorous requirements. Each broad category and, indeed, each specific use of fertility and mortality data presents a somewhat different mix of technical demands in terms of topical, temporal, and geographic detail as well as timeliness and accuracy. Table 1.1 illustrates the range of such needs.

Although any given user in any specific context would probably be interested in only a few of the cross-classifications listed in Table 1.1, many major users of fertility or mortality data and most large-scale programs aimed at changing fertility or mortality rates sooner or later would require most of the detail specified. For example, analysts examining the impact of any social program often need information on both program-related variables and demographic or socioeconomic control variables. Such studies may involve analyses carried out either at the aggregate or macro-level or at the level of individual women or families. For a user attempting to demonstrate the effectiveness of a new program or program modification, very detailed geographic breakdowns may also be required, again at either the macro or micro level.

User needs in terms of the timeliness of fertility and mortality data may range from minimal, in the case of some research scholars, to the "yesterday" of the earnest program administrator. A number of factors place constraints on the timeliness that is possible with fertility and mortality data in developing countries, but this is particularly so in the case of fertility. First, both fertility and mortality are phenomena that occur over time; one must wait for the year to end before learning the final figure for the year. Second, the seasonal swings of fertility and mortality are very much more pronounced and more irregular in developing countries than in the United States and most other developed countries, which means that extrapolations based on part-year data are hazardous and sometimes quite misleading. Third, data collection activities, particularly if organized on an ad hoc basis, usually have long lead times. Fourth, programs designed to reduce fertility or mortality are usually slow to gather momentum; hence, after a program has been operating for several years, policy makers and administrators may want demographic estimates for the most recent period, e.g., for the third and fourth years of a five-year plan period when they are developing the next five-year plan during year four or five of the current plan period. (Even in cases where changes in vital rates are achieved quickly, estimates for the most recent period are usually desired.) Finally, if the impact of a contraception program is to be measured in terms of the change in the number of births occurring in a population, it is not possible to assess it definitively until 9 months after the fertility-regulation behavior began.

While timeliness usually is thought of in terms of speed of data production, frequency and regularity are also factors in timeliness. In properly functioning collection activities there will usually be a reciprocal relationship between speed and detail as well as speed and accuracy. However, in the case of poorly functioning activities it is often possible to increase both speed and accuracy simultaneously.

1.3 THE CONTEXT OF DATA COLLECTION

In addition to the needs of users, the conditions and characteristics of the population being studied have important effects on the data collection process. Particularly in measuring mortality, it is important to emphasize the sharp differences that exist between the developed and developing nations, both in the aggregate phenomenon being measured and in the conditions of observation. Because of past and current levels of fertility and mortality, mortality in the developed nations occurs primarily among the elderly and rarely among children and infants. In contrast, in developing nations nearly half the deaths occur to those under age 15, and frequently more deaths occur in the first year of life than among those 65 years and over. Table 1.2, which shows the percentage distribution of deaths by age and the median age at death in selected developed and developing countries, illustrates vividly the magnitude of this difference.

In addition, the developed regions are characterized by the greater prevalence of the nuclear family as a living arrangement, greater urbanization, and greater availability and use of inpatient health facilities. Collectively, these factors interact with the different age patterns of mortality to accentuate the differences between the measurement situations in the two groups of countries. For example, while all surveys tend to omit the mortality of persons living alone or with nonrelatives, this is probably a much larger source--perhaps even the primary source--of omissions in surveys of developed countries, where deaths are concentrated among the elderly and where many of those over age 65 live alone or with nonrelatives. On the other hand, omission rates for the deaths of old people tend to be relatively low in developing countries, because the greater proportion of dwelling units with more than one nuclear family (which means that fewer people live alone) increases the probability that the deaths of older persons will be reported.

Another example of how the measurement problems differ between developed and developing countries can be seen in relation to infant mortality. While deaths of the very young tend to be underreported universally, the fact that few such deaths occur in the developed countries means that even very high omission rates have a minor impact on estimates of total mortality in those countries. The situation is almost reversed in the developing countries. There, high omission rates of the deaths of infants and children have a large impact on mortality estimates, because such a large proportion of the total deaths are those of infants and young children. Furthermore, the prevalence of multiple-family households increases the likelihood that a census or survey respondent will be someone other than the infant's mother and that the infant's death will be subject to the very high omission rates associated with such proxy respondents (Sirken and Royston, 1971).

TABLE 1.2 Percentage Distribution of Deaths by Age in Selected Developed and Developing Countries

Age at Death (years)	Percentage of Total Deaths	
	Developed Countries[a]	Developing Countries[b]
Less than 1	2.4	29.6
Less than 5	2.9	44.8
Less than 15	3.5	49.3
15-24	1.8	3.9
25-64	25.8	23.2
65+	68.9	23.7
Median age at death	71.8	16.3

Note: An examination of the age distribution of deaths for appropriate model stable populations suggests that these results would be altered only slightly if a larger number of countries were included in the analysis and the effects of age misreporting could be eliminated.

[a] Median values using data for year specified in 1977 U.N. Demographic Yearbook for Australia (1975), Canada (1975), England and Wales (1976), Federal Republic of Germany (1976), France (1974), Hungary (1976), Japan (1976), Netherlands (1976), Poland (1976), Spain (1974), Sweden (1976), and United States (1975).

[b] Median values using data for year specified in 1977 U.N. Demographic Yearbook for Algeria (1965), Cuba (1971), Guatemala (1972), Malawi (1971-72), Mexico (1974), Sri Lanka (1968), Tunisia (1973), and Turkey (1967-68).

1.4 ACCOUNTING FOR ERRORS IN DATA

Another major concern of users is, or should be, the accuracy of the fertility and mortality data they employ. While everyone agrees that accuracy is good and error is bad, people (statisticians, demographers, and non-technical users) often seem to have quite different things in mind when they use these terms. The resulting confusions and misunderstandings have sidetracked many discussions about demographic estimates and the methods used to obtain them.

All operations in the data collection process are subject to errors. For example, in census and survey work, there is evidence of large interviewer variances, coder variances, respondent errors in factual data, and large differences in average results between parallel surveys by different organizations. It would be impossible to measure and present each source of error for each census, vital registration system, or survey (much less to eliminate them) the way sampling errors in surveys can be computed and presented. (Even sampling errors need more attention, and the World Fertility Survey is establishing new precedents by including them systematically in their publication of each first country report.)

The multiplicity and complexity of sources of errors forces us to adopt a simplified yet useful conception: a model for survey errors. The concept of "individual true values" of each variable for each population element is a point of departure (Hansen et al., 1953). Thus we have a multiplicity of sources of errors superimposed on a group of variables for a population of elements.

For convenience, the statistical model divides the total error (the difference between the value obtained and the individual true value) into a pair of components for each source of error: a bias component and a variable component. The biases refer to the average errors for each source defined for a set of essential data collection conditions. For example, in a survey a particular set of interviewers would get some average understatement of abortion. That average bias could be different for a team of midwives vs. a team of interviewers, and they could be well or poorly trained, female or male, etc. Furthermore, within each team a good design might detect individual differences between interviewers; these differences can best be conceptualized, and hopefully measured, as variable errors arising from a set of interviewers "randomly" selected from a population of interviewers defined under the essential survey conditions. Another example is a vital registration system in which more closely supervised registration clerks in urban areas obtain more accurate information on age at death than clerks in rural areas. In addition, individual clerks carry out their registration tasks with more or less diligence. Here also these differences can be conceptualized as variable errors arising from a set of registration clerks "randomly" selected from a population of clerks defined under the essential conditions of the vital registration system.

Other sources of measurement error, such as coding, can also be divided into an average, systematic bias and a variable component of error. Nevertheless, for many purposes the chief attention with respect to errors of measurement should be paid to bias rather than to variable errors. However, for errors of sample selection the variable errors of selection will predominate and should be measured, because in well-designed samples systematic biases of selection can be reduced to negligible proportions compared to other sources of error.

It is frequently stated that measurement biases are more important in surveys and in other demographic data collection processes than are sampling errors. There is some truth in that, but only the partial truth of first approximations. It is probably true for most large demographic surveys and censuses that the overall means and rates are affected most by measurement bias. However, most data are also used to investigate subclasses; as these become small and as they are compared (within a cross-section, between censuses and repeated surveys, and across time periods in vital registration systems), the limiting factor almost always becomes the "size of the sample," that is, the sampling errors.

It is often, though not always, a false dichotomy to counterpose biases to variable errors. Both components give rise to the overall error. This is expressed as the total error, or the mean square error (MSE), which equals the square of the error plus the square of the bias. Its square root, the root mean square error, has wide acceptance as a good statistical criterion for the accuracy of results (Cochran, 1963:1.8, 1.9; Kish, 1965:13.1, 13.2, 13.8). Gauss had the first and best word on the mean square error in 1809:

> If one objects that this convention [the MSE] is arbitrary and does not appear necessary, we readily agree. The question which concerns us here has something vague about it from its very nature, and cannot be made really precise except by some principle which is arbitrary to a certain degree. . . . Among the infinite number of functions satisfying this condition, it seems natural to choose the simplest, which is, without doubt, the square of the error,

and in this way we are led to the principle proposed above (Gauss, 1809).

The total error of an estimate or the MSE can be considered as the sum of at least four error components:

(a) Sampling variance is a measure of variability of results from one sample to another sample of the same design and size from the same population. It arises because a probability sample rather than the whole population is covered. It can be measured (estimated) in well-designed samples.

(b) Simple response variance is defined as the variance of the observed values of independent measurements for an individual unit taken under the same conditions and averaged over the individual units (individual people, deaths, births, etc.). For a more technical definition see Appendix A.

(c) Correlated response variance is a measure of the variability due to intra-interviewer or recorder correlation and biases that persist from unit to unit and trial to trial (e.g., the tendency of the individual census taker, interviewer, registration official, or their supervisors to make the same errors repeatedly or more or less consistently).

(d) Biases refer to the average effects of systematic errors that affect any data collection process taken under specified design conditions. The biases may different in different subgroups.

A further discussion of mean square error, including an explanation of the formula, is found in Appendix A.

The MSE approach is an attempt to model total error as the sum of two components: bias and variable error. Another useful approach is to attempt to partition error according to its source, that is, to estimate the contribution to the error of the different survey processes (interviewing, coding, punching, imputation, etc.). Although it is seldom possible to cover all sources of error in this way, the approach may nevertheless yield valuable information for identifying weak procedures and optimizing the impact of corrective measures.

The MSE approach--which partitions total error into fixed and variable components or fixed, variable, and interactive components--was originally developed by sampling statisticians as part of their efforts to improve the design of surveys and the related sampling procedures used (Deming, 1950), but the same approach has been widely used by statisticians in other fields of science (e.g., Eisenhart, 1969).

The principal advantage of the MSE approach is that at least conceptually it provides a body of theory and a strategy that can be used to estimate the components of error and the total MSE. The validity of the MSE approach rests on how closely the assumed error model fits the particular measurement effort and on the extent and quality of the empirical data on errors that are developed and estimated through the survey design or otherwise available for use in applying the model. Considerable attention has been given to the latter problem by Seltzer (1973) and Marks et al. (1974).

1.5 COMPARATIVE ADVANTAGES OF DATA COLLECTION METHODS

Births and deaths are discrete events that occur in time and space. They are widely distributed in the population although at a comparatively low density; in most developing nations one would expect an average of about 10 to 25 births and considerably fewer deaths a year per 100 households.

Several broadly different techniques have been used to detect the occurrence of these isolated events and to assemble this and related information to provide reliable statistics about fertility and mortality behavior in the population generally. The techniques include:

(a) contemporaneous recording of each event as soon as possible after it occurs;
(b) retrospective questions about individual events occurring over some specified period in the past (for example, births in the last 12 months; sometimes for fertility data the question asked is date of last live birth, or a full birth history may be requested);
(c) retrospective questions about the cumulative number of events that have occurred (for example, number of children ever born);
(d) comparing the number of persons by age and sex (or by certain other characteristics) at one or more points in time to derive information about fertility or mortality as an aggregate phenomenon; and

(e) compiling a list of living individuals at one time, repeating the exercise in the same population after an interval of time, and deriving information about individual births and deaths from changes in the two lists.

These techniques are not necessarily mutually exclusive and are often used together. For example, the last method, sometimes referred to as either the "follow-up survey method" or the "household change technique," must be combined with some other method in order to obtain information about the occurrence of live births and related infant deaths occurring between the times when the two lists are compiled. That is, other questions must be asked to ascertain the occurrence of events that are not evident from changes in the two lists. Regardless of the specific technique or techniques used to identify the occurrence of births or deaths, it is essential that data collectors use procedures that are well defined and well controlled.

Three major methods of data collection are based on these five techniques for detecting births and deaths: the population census, the civil registration system, and the sample survey. Accepted definitions of a population census and a system of civil registration are included in Chapters 2 and 3 respectively. Definitions of the wide variety of sample surveys used to collect fertility and mortality data are described in Chapter 4. In addition to these three methods, a few developed countries also use population registers as a basic source of population statistics. Such a register, essentially a ledger or file of data maintained on each individual in the population, has no value as a source of continuing statistical data unless there is a mechanism for keeping it up to date. Since a comprehensive civil registration system is the basic component of any such mechanism, population registers are discussed in Chapter 3 along with civil registration systems.

Table 1.3 lists the five techniques for identifying vital events and indicates the degree to which they can be used in the context of each of the three major data collection methods. As the table shows, a civil registration system is by definition an application of the continuous recording technique. Three of the five techniques can be used in connection with a population census. Sample surveys offer the greatest opportunities for using different types and combinations of the techniques.

TABLE 1.3 Suitability of Various Techniques for Detecting Births and Deaths, Classified by Data Collection Method

	Data Collection Method		
Technique	Population Census	Civil Registration	Sample Survey
(a) Contemporaneous recording of each event	No	Yes	No[a]
(b) Retrospective questions about each event	Yes, but very limited[b]	Generally not applicable[c]	Yes
(c) Questions about cumulative number of events	Yes, but limited[d]	Yes in the case of fertility (parity)	Yes
(d) Aggregate population data classified by age and sex	Yes	Generally not applicable[e]	Yes
(e) Household change technique	No	Not applicable	Yes

[a] Some variations of a sample survey may include a continuous recording operation in sample areas or monthly or more frequent interviewing that approaches notions of contemporaneous recording. However, most sample surveys do not use this technique.

[b] Suitable only for a question relating to events in the last 12 months or the date of the most recent event. Totally unsuited for a full birth history. (Sometimes indirect estimation techniques can be applied to census data to construct better estimates.)

[c] Although by definition CR/VS systems involve the contemporaneous recording of each event, limited information on past fertility can be ascertained, for example, from a question on birth order.

[d] Often not feasible to use the recommended full battery of six questions (i.e., living in household, living elsewhere, born alive but now dead, each separately for males and females).

[e] Although CR/VS systems do not collect aggregate population data, it is possible to use CR/VS data to tabulate births by age of mother, deaths by age and sex, etc.

In fact, the sample survey method generally offers a very wide range of options, not only in terms of techniques used but also in terms of other factors related to the type, design, and execution of the survey. These factors include the number of questions asked, whether the survey involves one visit to each sampled household (single-round survey) or more than one visit (multi-round survey), whether information collected in the current visit is compared with or reconciled with previously collected information, whether the survey is carried out on an ad hoc basis or with the assistance of a permanent household survey organization, whether the survey is carried out by a governmental statistical agency or some other organization, the type and size of sample, the persons used as interviewers and supervisors and the workloads of each, the extent and nature of the training provided the field staff, the type and layout of the questionnaire used, the type and extent of manual and computer editing, and so on.

Although the variations possible in designing and carrying out a population census are considerably fewer than with a survey, variations can and do occur. Some of the major design issues and options that census planners face are presented in Chapter 2. Some of these options are not real options in all situations, because many features of census organization and design are dictated by external factors. For example, in a country in which most of the population is illiterate, the self-enumeration method of enumeration is not a real option. On the other hand, conditions change, so what can be considered a real option changes over time. Since the specific design options chosen may have a substantial impact on the measurement process and therefore on the quality of the data collected, users of census data should want to be sure that apparent intercensal changes in data are not the result of changes in census procedures. This point is particularly important for certain types of demographic estimation.

The basic design options in continuous recording of births and deaths can be expressed in terms of a 2-by-2 classification (Wells and Horvitz, 1978):

	Legal Status of System	
Effort of Field Staff	Civil Registration	Special Registration
Passive		
Active		

"Passive" in this table means that a member of the household or a person closely associated with a household (or with the specific event, e.g., the physician,

TABLE 1.1 Illustrative Listing of Detail Frequently Required in the Analysis of Fertility and Mortality Data

	Type of Data		
Type of Detail	Fertility	Fertility and Mortality	Mortality
Topical			
Summary	Crude birth rate General fertility rate Children ever born		Crude death rate
Specific[a]	By age (age-specific fertility rates) By age and marital status (marital age-specific fertility rates) By duration of marriage By previous reproductive experience variables By contraceptive and/or abortion practice variables By attitudinal variables By family-planning program variables	By employment variables By education By income By ethnic group By residence variables By nutritional status	Life table (usually by sex) By age (age-sex-specific death rates) By marital status By dependency status By characteristics of spouse or parents By cause of death By whether medically attended By previous health status
Temporal			
Vague	Cumulative	Current Recent Past	Generation[b]

Specific[c]	By age or marriage cohorts	Specified calendar year (or other, e.g., lunar) Specified group of calendar years Specified 12-month period Specified period greater than 12 months Specified period less than 12 months
Geographic		Entire country Urban/rural All major cities Each major city Each major civil division Each minor civil division Specified small areas Individual villages

[a] In most cases, an age control is almost always necessary also to allow for meaningful analysis.

[b] As in "this generation" or "changes from one generation to the next." The "generation life table" is a specific term that refers to the mortality experience over time of a group of people born in the same year or group of years.

[c] Each of these specific items refers to data that provide an estimate of the level of fertility or mortality during that time period and, in the case of infant deaths, during a specified number of months or weeks following birth. To obtain the temporal detail required to estimate change, it is necessary to have estimates for at least two time periods.

hospital staff member, or undertaker) brings the information concerning a birth or death to a staff member of the civil registration system. "Active" means that the staff member actually visits households to gather information concerning births and deaths. Special registration, as opposed to civil registration, means one operated under the auspices of some authority other than the central government, such as the church. Despite the considerable scope afforded by these four alternatives and the large number of countries that have undertaken the task, nearly all efforts at continuous recording of births and deaths involve an official civil registration system that depends on passive staff effort (that is, the upper left cell of the table).

The organization of registration systems varies greatly among countries--for example, which ministry has responsibility for the registration work and which carries out the statistical compilation work; whether notification responsibility falls on the family or on health, religious, or local administrative personnel; the hours and location of registration offices; whether the statistical data are compiled locally, regionally, or centrally; and so on--but within the same country there is much institutional continuity. Despite this institutional continuity, countries whose civil registration systems suffer from substantial incompleteness may be subject to sudden variation in the level of completeness. Although these variations sometimes are attributable to obvious organizational changes, more commonly they are due to subtle changes in detailed procedures or to registration drives. For example, the latter often produce a substantial number of delayed registrations with respect to current events.

A national civil registration system that functions as a reliable instrument of demographic measurement is more difficult to establish than a population census or sample survey since it must be more extensive both in time and space than either of the other two methods. In other words, a successful civil registration system must provide a means for detecting and recording substantially all births and deaths regardless of what time of year or where in the nation each event takes place.

A population census, while equally broad in geographic scope, is a single effort carried out once, or at most twice, each decade. As a result, extensive administrative and technical resources can be specially mobilized in an effort to keep the data-gathering and data-processing operations under as much control as possible. Indeed, such a special mobilization of resources is essential if major errors in coverage and content are to be avoided.

The sample survey, restricted as it is to a small proportion of the population, is in a much better position than either the census or the civil registration system to produce observations made under conditions that approach the ideal of statistical control. This is particularly true when, as is the case with most survey sample designs, the sample is confined to a relatively small number of geographic areas. In that situation, it is possible to train and supervise the field staff more effectively than in either a census or civil registration system and to insist, where appropriate, on direct rather than proxy interviews. Furthermore, as Table 1.3 indicates, the sample survey is the most versatile of the three collection processes in terms of the techniques it can use to detect births and deaths.

Against these advantages must be placed the disadvantages that arise because sampling is being used. One disadvantage is that for a census there is better publicity and better public understanding, which may lead to improved respondent cooperation. This may be a factor in the higher coverage that has been observed in censuses as compared with many sample surveys. In addition survey estimates are subject to measurable sampling errors if a probability sample is employed; even greater uncertainties arise if some other sampling procedure is used. Thus, non-probability or "new sampling designs" that depend on the validity of assumed models should not be used to collect fertility and mortality data; standard probability sampling should be employed. One example of the extent of uncertainties that can arise when a non-standard technique is used is described by Trussell and Brown (1979) in their analysis of Afghanistan data.

User confidence in the estimates is an important issue when data are collected by a sample survey. The impact of sampling errors on fertility and mortality estimates can be substantial, particularly with respect to crude rates and age-specific rates based on sample data for a single year. Table 1.4 illustrates how large such errors can be even under perfectly controlled conditions. If one probes further into questions of error (as outlined in the preceding section), there is even greater variability than indicated by the ranges in Table 1.4.

TABLE 1.4 Examples of Approximate Sampling Errors Associated with Estimates of the Crude Birth Rate and the Age-Specific Fertility Rate, by Size of Sample

Size of Sample[a]	CBR ± 2σ	ASFR ± 2σ
1,000	28-52	133-467
3,000	33-47	203-397
5,000	35-45	225-375
10,000	36-44	247-353
50,000	38-42	276-324
100,000	39-41	283-317

Note: Sampling errors shown are the two-sigma (2σ) confidence intervals around an assumed crude birth rate (CBR) of 40 per 1,000 population and an assumed age-specific fertility rate (ASFR) of 300 per 1,000 women aged 30-34. Calculations assume that women aged 30-34 comprise 3 percent of the total population, e.g., for a sample size of 1,000 there are 30 women aged 30-34, for a sample size of 5,000 there are 150, etc.

[a] Assuming a simple random sample of persons and a sampling fraction of about 10 percent or less.

Source: Seltzer (1973).

Moreover, the mere fact that a sample survey is used does not guarantee that the data will be collected in a carefully controlled manner.

1.6 THE ESSENTIAL COMPLEMENTARITY OF DATA SOURCES

No single data collection method can supply the full range of fertility and mortality data needed by different countries and by different users within those countries. Each of the three major methods--census, civil registration, and sample survey--has advantages and limitations. To be most effective, they must be used in concert to gather the various types of data needed for policy making, administration, and research; to provide mutual cross-checks on accuracy and completeness of coverage; and to collect the combinations of data that are needed to apply some of the more powerful estimation techniques. If planned and carried out in coordination with each other, their advantages can be maximized and their limitations reduced.

The essential complementarity of the methods is reflected in Table 1.5, which indicates their relative strengths in providing different types and quality of data. Table 1.6 displays some of the other advantages and limitations of each method.

In both tables the relative advantages of the three methods are shown to be complementary: where one is strong, another is weak. For example, sample surveys can be designed to obtain wide varieties of data with rich content, and they can be designed to collect the data relatively accurately. Because they are small they can be done fairly inexpensively and can provide timely data, but for the same reason they fail to yield precision and geographic detail. These last two criteria, on the contrary, are the chief virtues of complete censuses (although censuses are by no means immune to coverage problems themselves). Censuses (and well-developed civil registration systems) tend to produce better coverage of the population than sample surveys, which often suffer from higher non-response (although non-response levels vary greatly between surveys and among individual items in surveys). Because censuses are large and expensive, however, they are not conducted frequently and often produce data that are partially obsolete because of the time required for collecting and processing the data and disseminating the results. To obtain either rich or accurate data from a census is often not feasible.

Civil registration systems have a different mix of advantages than either surveys or censuses. Once established, civil registration systems can be inexpensive to maintain if some of the costs are considered necessary for administrative purposes, although to date this is the case in only a few of the developing nations. Moreover, civil registration systems can yield precise, timely, and detailed information about levels and trends in fertility and mortality provided they are tied to good census data.

Sample surveys are an important tool for obtaining fertility and mortality data and for carrying out demographic research at all stages of statistical development, however it is a mistake to think of them primarily as an interim means of supplying data in the

TABLE 1.5 Intrinsic Characteristics of Data Collection Methods in Providing Data Needed to Estimate Fertility and Mortality: A Comparison Using Seven Criteria

	Data Collection Method		
Criteria	Census	Civil Registration	Sample Survey
Topical detail (richness and diversity of subject matter)	Moderate	Weak	Strong
Accuracy	Moderate	Strong	Moderate
Precision (absence of sampling errors)	Strong[a]	Strong[a]	Weak
Timeliness of data	Weak	Strong	Strong
Geographic detail (subgroups, etc.)	Strong	Strong	Weak
Obtaining information on population at risk[b]	Strong	[c]	Strong
Ease of organization in a developing nation	Moderate	Weak	Strong

[a] An important qualification must be noted. With respect to arriving at inferences, censuses and CR/VS systems are subject to sampling errors. For example, if one has a death rate for a city or county (based on complete registrations and a complete census) or for a specific cause, based on a small sample, and it differs from the death rate in another area (or for another cause), the difference may well be due to the number of observations involved and may not represent any real underlying difference in the cause systems. Thus, when the inference is to a cause system, as is common, census and complete registration results are subject to sampling errors.

[b] The "population at risk" refers to the group of persons who are subject to the events that are counted, measured, or analyzed. For example, the population at risk for the crude death rate is the entire population in the area under measurement or study. The population at risk for each age-specific fertility rate consists of all women in that age group. The population at risk of infant mortality includes all live-born children during their first year of life. (The infant mortality rate is frequently approximated by dividing the deaths to children under one year of age during a year by the number of births occurring in that year.)

[c] In general, CR/VS systems do not provide information on the population at risk. However, for some measures, such as infant mortality, CR/VS systems do provide data on the population at risk. Also, historical analysis is possible when CR/VS data from earlier periods are available.

absence of a reliable civil registration system. Undoubtedly, surveys can be used for this purpose but they can never adequately meet the range of needs served by a national civil registration system. By the same token, even with the most complete and comprehensive civil registration system it is essential to continue an active program of sample surveys.

Another very fruitful way of drawing on more than one data collection method is to combine the use of sampling techniques with a census; this subject is treated in detail in Chapter 2. In countries where the census data are of good quality and where the age data are reliable (e.g., in a few developing countries in East Asia), special analytic techniques can be used to construct fertility and mortality estimates normally obtained from civil registration data. In the application of one such technique, own-children analysis, an estimate of child mortality is required; frequently this estimate is derived from data obtained from a survey or sometimes a civil registration system.

In addition to their use in collecting fertility and mortality data censuses, surveys, and registration systems serve a variety of other specialized needs. For example, censuses are required for purposes related to civil administration and apportionment (e.g., determining the distribution of seats in a legislative body, the allotment of taxes, or the distribution of funds on the basis of population counts). Surveys are a valuable means of testing questions for possible use in censuses, and registration systems serve the socially important function of providing a legal record of vital events. Censuses and surveys can be used to estimate the completeness of national vital registration systems, and in many developing countries the need to see how well or poorly the civil registration system is functioning helps spur the development of complementary data collection systems.

A coordinated approach to data collection is essential because it allows the inherent or temporary deficiencies of any one method to be counterbalanced by the comparative strengths of another. This is as true for countries that have reached a comparatively advanced state of statistical development as it is for countries in which one or more of the data collection systems is limited in geographic scope, seriously deficient in coverage, or otherwise functioning inadequately. For best results, the concepts, definitions, and classifications used in the census, the civil registration system, and any surveys used to provide demographic data should correspond with each other as closely as possible. In the context of fertility and mortality estimation, common, or at least compatible, approaches to age-group classifications, household and residence definitions, and urban/rural and other area classifications are particularly critical. Also important are the concepts and classifications used in connection with questions on family relationships, marital status, and children ever born and children surviving.

1.7 LONG VS. SHORT PLANNING HORIZONS

Although there is wide agreement with the view that population censuses, civil registration systems, and sample surveys are essentially complementary in nature, there is less agreement about appropriate strategies for improving national data collection efforts. In part, this disagreement springs from the varying priorities placed on the different possible uses of the fertility and mortality data. A user who wants annual assessments of fertility in specific sub-national areas is likely to place greater emphasis on improving the civil registration system than a user who wants general information on the level of fertility in the country as a whole, who may feel that improving survey capabilities are more important. Complicating this issue is the question of how much of the future (how many years) to take into account when considering proposals for improving data collection activities. We refer to this number of years as the planning horizon.

In deciding how to allocate the often scarce resources available for improving data collection activities, one inevitable trade-off to be made is whether to emphasize actions that will bring short-term benefits (such as a crash program of interviewer training that will improve the quality of sample surveys) or those that will result in benefits farther down the line (for example, investing in computer equipment for the census or earmarking a larger portion of the annual budget for expanding or strengthening the civil registration system). For all such decisions, the choice of planning horizon is crucial.

The planning-horizon issue arises most often in connection with decisions about devoting "substantial" resources to the improvement of civil registration systems. The issue is also relevant when deciding if resources should be spent on preserving some minimum level of census capability during the intercensal years (Stouffer, 1938) and on establishing a permanent organization to perform national surveys (United Nations, 1978b).

If the planning horizon being used is comparatively brief, resources for data collection are allocated almost solely on the basis of immediate needs for specific data. The benefits resulting from longer-term improvements in data collection operations are ignored or given low priority. Under such a view, heavy reliance is placed on ad hoc sample surveys to serve immediate data needs, and few resources are allocated to establishing a national survey organization or to improving the civil registration system. At times, this short-term view has also led to questions about the value of the population census.

Data users and planning officials who adopt longer planning horizons generally have more interest in allocating resources to long-term development of civil registration systems, periodic censuses, and a continuing national survey organization. They also may be more interested in funding methodological research, for example, research to determine which design options for enumeration and processing may be most appropriate in their country.

The length of planning horizons chosen depends on several factors: the importance attached to obtaining reliable data on time trends; concern with a range of data uses rather than a single use; realism, or lack thereof, about the time needed to plan and carry out statistical operations; awareness of the uses of fertility and mortality data and of the operations required to produce them; and views on the degree to which better statistics can contribute to better policy making, administration, or research. Clearly, users who place considerable emphasis on the need for time-series data on fertility and mortality (for example, Bean, 1978) or those who emphasize the contribution that better information can make to better decision-making and science (for example, Juster, 1974; Leontief, 1971; Rivlin, 1974) have little difficulty looking relatively far into the future in terms of data needs or the benefits that may accrue from current investments in improving the statistical capacity of a country.

As is the case with most demographic, social, and economic statistics, a brief planning horizon is unrealistic and counter-productive when making decisions about fertility and mortality statistics. A planning horizon of less than 3 to 5 years is unrealistic for any type of fertility and mortality measurement, including the measurement of levels, and longer planning horizons are needed to measure trends. This is so because almost all good ad hoc surveys that are national in scope take at least two years to plan and carry out and at least another year to analyze the results; many take considerably longer. For a multi-round program of surveys, the time frame is necessarily longer. The length of time required to plan, carry out, and analyze a population census is comparable (at least three years), and with respect to planning and preparatory activities it should be considerably longer. For a program of decennial censuses the planning horizon is at least ten years and a permanent organization is necessary. For all data collection methods it is essential to plan the whole process from beginning to end, including tabulation, processing, and analysis.

The relatively long lead time required to carry out even the "quick" ad hoc survey, if it is not to be too "dirty," is imposed by the need to carry out observations under controlled circumstances. The sample design, the segment maps or house listings provided the interviewers, the survey questionnaire, and the training and supervision of the interviewers and their immediate supervisors are all part of the effort of achieving controlled observations. Such procedures inevitably take time to develop and test, particularly if they are to be robust enough to function adequately in a measurement effort that is national in scope.

The long delay between a decision to collect data and the production of useful estimates is highly frustrating to users. But such delays are in part an inevitable consequence of allocating resources for statistical operations on the basis of a very brief planning horizon and the consequent emphasis on current consumption of statistics at the expense of capital improvements in the infrastructure required to produce them quickly and efficiently. The existence of a continuing organization equipped to conduct national sample surveys generally can shorten this three-year lead time and also provide the flexibility of being able to respond to data needs as they evolve. A well-functioning civil registration system can often provide basic fertility and mortality data with only a three- to six-month time lag. Of course, both these systems require a decision to make capital investments in statistical-production capabilities. In most countries, allocations for both activities can be justified in terms of a planning horizon of ten years, the interval between successive censuses in most countries (although some countries conduct or are planning to conduct quinquennial censuses, e.g., Korea, Turkey, and the Philippines). This means that current allocations of data collection resources should include investments that may not produce usable results until ten years later.

The existence of a permanent data collection organization does not guarantee that all data collection will proceed without problems and in a timely manner. One problem is that of bureaucratic degeneration: older institutions are inclined to slow down. In addition, queuing problems can develop: in a continuing program, processing of one survey may have to await completion of the one ahead in line, and traffic jams easily result. Sometimes CR/VS systems are several years behind in the publication of results because of such queuing problems, and there are instances of data from one census being published after the subsequent census has been taken.

1.8 COSTS OF DATA COLLECTION

1.8.1 Comparative Costs of Different Collection Methods

Relatively little has been written about the costs of data collection, although there are a few exceptions to this bleak generalization: for example, Eckler (1970), Louwes (1967), U.S. Bureau of the Census (1963), and National Academy of Sciences (1976). In the context of the collection of fertility and mortality data, most references to costs have been statements on the order of "Method A is cheaper than Method B for obtaining data, so Method A is preferable." As a rule, such statements have two main faults: first, the methods referred to in these comparisons, and hence the comparisons themselves, are not precisely defined; second, the statements are based on an impression of how much something costs and not on quantitative information on costs.

Such vagueness and lack of rigor concerning costs hamper the recording and analysis of information on costs

TABLE 1.6. Some Advantages and Limitations of Population Censuses, Civil Registration Systems, and Sample Surveys

Data Collection Method	Advantages	Limitations
Population Census	1. Data can be tabulated for many local geographic areas. 2. Detailed cross-tabulations are not subject to sampling errors for complete-count items (except when arriving at inferences--see footnote a in Table 1.5) and are subject to relatively low sampling errors for sample items. 3. Simultaneously obtains information related to enumerated events and population at risk. 4. Useful for time series covering long periods of time.	1. Infrequent. 2. Limited range and depth possible in the collection data on fertility and mortality as well as on classifying variables. 3. Information on "flow" variables (for example, income, births, deaths) and data from proxy respondents are subject to increased levels of response error. 4. Persons not at their usual place of residence are subject to high non-response rates (a lesser problem in de facto censuses). 5. Comparatively difficult to control conditions of observation (because it is extensive in space). 6. Costly and massive in scale, so relatively inflexible.
Civil Registration System	1. Data can be tabulated for many local geographic areas. 2. Detailed cross-classifications often not subject to sampling error. (See footnote a in Table 1.5)	1. Need for separate estimates of population at risk. 2. Limited range and depth possible in the collection of data on classifying variables.

	3. If properly functioning, provides contemporaneous reporting for substantially all events regardless of household status. 4. Institutional continuity. 5. Well-suited for providing both long-term and short-term time series.	3. Relatively inflexible to changes in content and procedures. 4. Very difficult to administer and supervise (because extensive in both time and space). 5. Difficult to establish occurrence of events when births and deaths (or knowledge of them) are not associated with individuals who can serve as informants (for example, health workers or religious personnel).
Sample Surveys	1. Simultaneously obtains information related to enumerated events and population at risk (with the exception of surveys conducted as parts of dual-record systems). 2. Topical flexibility (that is, the depth and range of topics investigated can be altered relatively easily). 3. Conditions of observation are subject to control in a well-designed and administered survey because of the limited geographic scope of collection operations (that is, because a sample is employed). 4. Relatively easy to initiate given availability of a survey-taking infrastructure. 5. Can be useful for time-series analysis, given comparability in data collected.	1. Inability to produce estimates for local areas. 2. Detailed cross-classifications are subject to large sampling errors. 3. Information on "flow" variables (for example, income, births, deaths) and data from proxy respondents are subject to increased levels of response error. 4. Coverage for the nonhousehold population is very poor and it varies markedly for those who are not members of a primary family (for example, members of secondary families, secondary individuals, and distant relatives of the household head). 5. Comparisons over time of estimates based on different ad hoc surveys are subject to many uncertainties. 6. Requires close supervision of field work.

of data collection and, ultimately, the proper use of this information in making policy choices concerning data collection programs. We can illustrate the problem of vagueness with a concrete example. Two common arguments in planning circles are these: "Population censuses are very expensive, so countries, particularly developing countries, should take sample surveys instead" and "Reasonably reliable estimates of fertility or mortality can be obtained at much lower cost by including a few Brass-type questions in a census or one-time sample survey than by carrying out a multi-round survey, using a dual-record system, or trying to improve the civil registration system." These statements contain elements of truth. However, they contribute as much to an intelligent understanding of the comparative costs and trade-offs involved in data collection as the statement "Automobiles are cheaper than trucks or buses, so one should buy an automobile" contributes to a better understanding of buying decisions in the transportation field.

Discussions of the comparative cost of several products have to be based on an appropriately precise description of the products involved, particularly those aspects of each product that relate to its intended use, and on a clear sense of how much precision one is willing to pay for. These basic points are sometimes disregarded. As discussed earlier, estimates of fertility and mortality levels and trends serve a wide variety of uses. Thus in any discussion of comparative costs there must be some effort to place the discussion in the context of a specific use or, more realistically, a range of uses. Because different uses require different levels of precision and place quite different technical demands on the data collection processes involved, taking uses into account will inevitably lead to a less simplistic view of any attempted costs comparisons.

1.8.2 Accounting for Costs of Different Elements of the Process

Another complicating factor in considering costs is the need to take into account the entire data collection process and not merely one or two elements of the process. The census, the civil registration system, and the sample survey should each be understood as a process or system; changes in one stage of the process often have far-reaching effects on other stages. In general, the greatest attention to costs has been given to those directly related to census or survey field work. However, sound decisions on data collection policies are best made after considering the cost of the entire collection process. This, in turn, means that the entire collection process--including planning, training, coding, tabulating, etc.--must be specified, not merely those activities related to the field work. (For examples of the specification required, see Louwes, 1967; Seltzer, 1972; and United Nations, 1978a: paras. 46 and 48.)

Furthermore, although the terms "census," "civil registration," and "sample survey" each refer to a reasonably well-defined process, there is considerable scope for variation within each category. (Automobiles and trucks differ from each other, but among automobiles a Bentley is quite different from a Datsun 210.) The importance of specifying aspects of the field work that have significant cost or quality implications is widely recognized, though not always acted upon, by survey statisticians. The significance of differences in the other aspects of censuses or surveys is less widely recognized.

Two examples may help illustrate these points. The first concerns user services for population census data. One country may decide to spend substantial funds to reorganize the census files in the form of a computerized data base. The existence of such a census data base may facilitate extensive and highly creative use of the results of the population census for policy and basic research purposes by enabling the census office to respond cheaply and quickly to a wide range of requests for ad hoc tabulations in the post-census period. Another country may not make this investment. As a result, it is substantially more expensive, more difficult, and more time-consuming for the second country's census office to respond to equivalent ad hoc requests. The cost of the field work for the two censuses in per capita terms may be roughly the same, but the additional costs and the additional benefits of the highly accessible computerized data base properly complicate efforts at facile cost comparisons.

The second example concerns large-scale surveys. It is probable that the cost of the World Fertility Survey (WFS) program, exclusive of second stage analysis, will total approximately U.S. $40 million by 1982. This amount includes funds spent on central office activities from the inception of the program in 1972 as well as funds spent in developing countries. The latter covers the money paid by external technical-cooperation agencies and an estimate of the survey costs paid by the participating developing countries. Assuming that approximately 40 developing countries will ultimately participate in the program, the average costs are likely to be about $1 million per country survey and between $200 and $250 per eligible woman sampled. A per-interview cost of this magnitude is high by traditional standards, particularly in the context of survey work in developing countries. (For several countries, some of the information can be obtained from a variety of surveys, such as the National Demographic Survey and other surveys in the Philippines.) However, this WFS per-interview cost is at least to some extent misleading since about half of total data files in about half of the countries contain household interviews that produce data useful for many other purposes besides fertility estimation. Furthermore, the WFS program has given high priority to quality control and to obtaining data of high quality in all countries in the program. Hence the following activities are all reflected in the total cost:

(a) High level of technical assistance.
(b) Insistence on pushing every survey through to completion, at any cost (with three exceptions in which there was a political decision by the country to stop the survey).
(c) Insistence on full data cleaning and production of standardized tapes.
(d) A variety of supporting activities, including regional conferences, national meetings, bringing national staff to London for training, and production of standard computer packages such as COCGEN and CLUSTERS.
(e) Investment in the countries' on-going survey capabilities through such activities as constructing the master sample in Egypt, creating the sampling frame in South Sudan, and providing in-country instruction in the use of COCENTS and CONCOR (see footnote on Figure 2.3; these are computer programs developed by the Centro Latinoamericano de Demografia [CELADE] and the U.S. Bureau of the Census).

In addition, there were expenses for the preparatory phase of the program, including the cost of developing the standard WFS core questionnaire and related subject-specific questionnaire modules. Hence, if the cost comparison of WFS with other surveys were limited to field work costs, it is likely that WFS field work would be on average only slightly costlier than other ad hoc fertility surveys.

It is worth noting that despite elaborate planning by the WFS, it has been difficult for the program to obtain information on actual, as opposed to budgeted, expenditures. Most countries simply take the budgeted money and place it into their government account. They then make the necessary expenditures--e.g., field workers' salaries--but no itemized accounts are kept. The government knows only that it paid all its employees each month, and the size of the total wage bill, perhaps by ministry.

1.8.3 Cost Allocation and Budgetary Practices

The census and WFS examples just cited also illustrate three other difficulties in assessing the cost of a particular census, survey, or civil registration program, or the cost-effectiveness of any specific data collection technique. First, it is often difficult to know how to allocate certain expenses among closely related census or survey programs. For example, certain continuing cartographic activities contribute significantly to both the quality of a decennial population census and to the quality and cost-effectiveness of intercensal household-survey programs used to generate fertility and mortality data. Similarly, it is often difficult to make a clear-cut allocation of expenses for a wide variety of user services among closely related census, survey, and vital statistics programs, particularly when they are carried out by the same agency of the government.

Second, there is wide variation in the comprehensiveness of census and survey budgets. In some cases this arises out of normal accounting practices. For example, census enumerators and supervisors may be hired and paid by local governmental authorities, so the cost of the field staff never appears in the national government's census budget. In other cases, the field staff may be school teachers or other government employees who are made available "at no cost" to the census authorities by another government ministry. A major cost item in a census is transportation. Frequently, army vehicles are utilized, and these costs are absorbed by the military rather than the census budget. Variations in comprehensiveness with respect to time also cause differences in census cost comparisons. Some countries may include in their census budget the cost of all preparatory activities for the census regardless how far in advance they occur; others begin the budget accounting an arbitrary four, three, or two years before the census.

In the United States, virtually the full cost of the census is born by the central government, though in some instances local governments supply free space or other services. In Germany, the system is much more complex. Local administrative areas and the cities are required to make significant contributions of personnel. In return, they receive contributions from the central government, which covers a large share of the total cost. In some countries, employees at various levels of the government are required to perform service in connection with the census and may or may not receive some bonus for that work. For example, in Puerto Rico in 1970, elementary school teachers were required to perform a month's public service in addition to their teaching responsibilities, and they could satisfy this requirement by working on the census.

However, it is unrealistic to assume that such contributions of personal services are cost-free. Experience in the United States indicates that enumerators and other workers who are contributed by a local government may require much more intensive training and supervision than is the case with persons recruited in the usual way. Furthermore, teachers, students, and other occasional personnel may all stop enumerating at a preassigned date whether their assignments have been completed or not. However, in a country in which the teachers are the only adults in a local village who can be presumed to be able to read and write, there may be little choice about local enumerators.

Similar kinds of problems arise in the case of survey programs and civil registration systems. Surveys make use of a range of infrastructure services; if these services are charged to a single survey or amortized over a relatively short period, the cost of the survey will seem high. If these infrastructure costs are ignored or are properly amortizable over a long period, the cost of the survey will, other things equal, seem low. Because civil registration systems have both a legal and statistical function and because they are often carried out as a minor part of other administrative activities on a highly decentralized basis, almost no information exists concerning the costs of obtaining vital statistics from national civil registration systems.

Third, cost comparisons are often greatly affected by whether or not the cost of large one-time capital expenditures are charged to the statistical budget in question. The issue arises most frequently in the case of a population census for which new data-processing equipment or a new software system is being acquired. Such acquisitions are often justified on the basis of their use in processing the population census data and are charged to the census budget. In countries that have upgraded their data-processing capability for other reasons--for example, in connection with the census of agriculture--the capital expenditures charged to the population census are nominal.

1.8.4 The Prospects for Improved Cost Analysis

Many of the issues of product specification and costing discussed here in the context of demographic data collection are only particular instances of more general issues that are widely encountered by economists and managers: the proper allocation of costs to current and capital improvement accounts, the proper allocation of common expenses to specific product lines, the treatment of costs incurred over a period of rapid inflation, the drawbacks of using exchange rates in international comparisons of costs for products that do not enter into international trade, and the special problems of cost accounting that arise in most public-sector activities.

There is no right way to resolve these issues. As with demographic statistics, fiscal data may be best handled in one way for one purpose and in another way for another purpose. Nevertheless, the development of costing conventions that would help in resolving these issues would be as helpful to those who administer statistical programs as the existence of similar accounting conventions is to managers of automobile manufacturers or oil companies.

Some of the obstacles to the collection and analysis of meaningful cost data can be overcome by concentrating first on comparing the resources used in censuses, surveys, and civil registration systems rather than the budgets or expenditures for these programs. For example, such resources can be measured in terms of how many person-hours of enumerators were needed for the census or survey, how many computer hours were required to process the data, how many square meters of office space were required for the staff, how many person-months of supervising and professional staff were required, etc. Such an approach does not, however, overcome problems related to vague specifications nor does it resolve the question of how to allocate common resources among specific programs.

As yet, there are no generally recognized conventions for assessing the costs of data collection and other statistical activities. Although the Statistical Office of the United Nations, with financial support from the U.N. Fund for Population Activities, is now undertaking a study of the cost and staffing requirements of population censuses, it is likely that a considerable period of experimentation will be needed before useful conventions can be developed and agreed upon, even in the relatively simple case of the population census. In the meantime, it is all the more important that persons and groups recording, reporting on, and discussing comparative cost data state clearly how they are resolving these issues, specify as completely as possible the entities they are comparing, and place any discussion of costs in the context of the benefits received relative to an appropriate range of uses.

Table 1.7 is an attempt to list some of the factors affecting the costs of the three major data collection systems. For clarity, the factors are grouped under three broad headings: (A) factors related to the population of the country and the circumstances in which the population lives; (B) factors related to the collection method itself; and (C) factors related to the accounting or budgetary practices employed.

Type A factors arise out of the geographic, demographic, political, cultural, economic, or social circumstances of each country; they represent the constraints under which any national statistical operation must operate. Although they are givens for any one-time collection effort, Type A factors may change over time. Type B factors are, at least in theory, under the control of those directing the data collection program. In fact, however, planners seldom have full discretion on decisions relating to these factors. Type C factors, as noted above, are often critical determinants of how expensive a method appears to be relative to other options, because they define the measuring sticks that are used in calculating costs. As with any classification system, difficulties arise in drawing the boundaries between categories. For example, should a high rate of inflation be considered a Type A factor or Type C? It is clear, nevertheless, that each of the three types of factors can have a significant upward or downward effect on the apparent cost of a census or survey.

It should be stressed that Table 1.7 speculates only on the likely impact of each factor taken one at a time; that is, the direction of the relationship indicated between each factor and overall costs assumes that all other aspects of the collection process (for example, quality and timeliness) are held constant. Furthermore, the table says nothing about the relative importance of any given factor compared to other factors. In practice, the importance of individual factors is determined partly by the impact of other factors and partly by how those administering the program decide to handle the trade-offs between cost on the one hand and quality, timeliness, and detail on the other. Another limitation of the table is that it omits the question of governmental structure, which has a major effect on how a data collection effort operates and how resources are allocated. In countries with highly centralized governments, the data collection operations are the responsibility of one or two units in the central government, while in other countries decentralized government units have major data collection responsibilities. For example, in the United States, the states are responsible for collecting information on vital events and for determining what data to collect.

1.8.5 Cost Efficiency of Long-Range Planning and Funding Support

Finally, bilateral and international aid agencies frequently have taken a short-term view regarding the financing of data collection activities. These agencies, partly for budgetary reasons of their own, are more willing to fund specific, short-term projects than longer-term development of statistical and data collection organizations. The development of CR/VS

TABLE 1.7 Likely Relationship Between the Costs of the Data Collection Systems and Specific Determining Factors

	Direction of Gross Relationship to System Costs[a]		
Determining Factor	Census	Survey	Civil Registration
A. Factors Related to the Population and Its General Circumstances			
1. Size of country	Direct	Direct	Direct
2. Population size	Direct[b]	N.A.[c]	Direct
3. Average household size	Inverse[d]	Inverse[d]	N.A.
4. Proportion of population living in primary families	Inverse	Inverse	N.A.
5. Heterogeneity of population with respect to languages spoken, cultural patterns, etc.	Direct	Direct	Direct
6. Extent to which "natural population clusters are homogeneous with respect to fertility and mortality	N.A.	Direct	N.A.
7. Level of literacy	Inverse	Inverse	Inverse
8. Proportion of population living in large cities	Direct	Direct	Inverse
9. Proportion of population living in small towns or compact and well-bounded villages	Inverse	Inverse	Direct
10. Proportion of population living in scattered and isolated housing units	Direct	Direct	Direct
11. Proportion of households with a telephone	Inverse	Inverse	N.A.
12. Proportion of population who present special problems during enumeration/interviewing/registration	Direct	Direct	Direct

13.	Proportion of population away from their usual place of residence at the time of the data collection effort	Direct	Direct	N.A.
14.	General level of administration development[e]	Inverse	Inverse	Inverse
15.	General level of wage rates for those with at least a primary education (the potential pool for staffing the system)[f]	Direct	Direct	Direct
B.	Factors Related to the Data Collection System Itself			
1.	Existence of continuing census or sample survey	Inverse[g]	Inverse[h]	N.A.
2.	Extent to which cartographic preparations have to begin de novo	Direct	Direct	N.A.
3.	Extent of cartographic preparations required	Direct[i]	Direct	N.A.
4.	Extent to which special house-listing operations are required	Direct	Direct	N.A.
5.	Number of separate schedules, questionnaires, or forms used by the interviewer or registrar	Direct[j]	Direct[j]	Direct
6.	Total number of questionnaire items	Direct[k]	Direct[k]	Direct
7.	Extent to which sample frame has be be constructed de novo	N.A.	Direct	N.A.
8.	Existence of permanent field organization	Direct[l]	Direct[m]	N.A.
9.	Extent to which infrastructure has to be established specifically for the data collection system	Direct	Direct	Direct
10.	Number of primary sampling units (PSUs)	N.A.	Direct[n]	N.A.
11.	Average size of PSUs	N.A.	Direct[o]	N.A.
12.	Total size of sample	N.A.	Direct	N.A.
13.	Proportion of questionnaire items precoded	Inverse	Inverse	Inverse

TABLE 1.7 (continued)

	Direction of Gross Relationship to System Costs[a]		
Determining Factor	Census	Survey	Civil Registration
14. Extent to which self-enumeration method is employed	Inverse	Inverse	N.A.
15. Extent to which proxy interviews are accepted	Inverse	Inverse	Inverse
16. Extent to which interviews/follow-ups are done by telephone	Inverse	Inverse	N.A.
17. Number of call-backs specified	Direct	Direct	N.A.
18. Extent of training and supervision provided	Direct[p]	Direct[p]	Direct
19. Extent of traveling required	Direct	Direct	N.A.
20. Ratio of interviews to interviewers (daily average)	Inverse	Inverse	N.A.
21. Extent to which special procedures to improve coverage or quality are employed	Direct	Direct	Direct
22. Extent to which the public, or important population subgroups, are fearful or apprehensive about the data collection method or the information to be collected	Direct	Direct	Direct
23. Level of detail sought in responses	Direct	Direct	Direct
24. Use of fertility-history approach	Direct[q]	Direct[q]	N.A.
25. Number and detail of tabulations run	Direct[r]	Direct[r]	Direct
26. Number and volume of reports published	Direct	Direct	Direct

systems suffers in particular from this short-term approach. While any given project provides experience for the persons carrying it out, the project-to-project approach that exists in many countries is not the best way ultimately to develop a comprehensive data-collection capability.

Officials in LDCs are sometimes criticized for having short-term planning horizons for data collection. However, planners and other officials in LDCs usually are keenly aware of what activities are and are not likely to attract attention and funding from multilateral and bilateral aid agencies. They observe that shorter-term projects get funded more readily than longer-term development activities, and this naturally influences the direction of their efforts.

If this short-term approach is to be overcome, bilateral and multi-lateral aid organizations must encourage and provide funding for the long-range development of data collection personnel and facilities for use in censuses, CR/VS systems, and surveys. In effect, funding agencies should be willing to adopt and apply a long-term planning horizon in their own aid programs for demographic data collection.

1.9 SUMMARY

The major conclusion of this overview of data collection methods can be stated briefly: There is no one best source for obtaining fertility and mortality data and no one best design for applying any given data collection method. For this reason, if all users with important needs for fertility and mortality data are to be effectively served, attention and resources must be directed to a balanced program of upgrading census, registration, and survey capabilities and activities within developing countries. This balanced program will vary among countries because priorities, time constraints on data needs, and planning horizons differ.

Several general themes run through this chapter, and through the entire report. First, rational, effective, and efficient policy-making and program administration are enhanced by timely, reliable, and appropriate data. In those few cases where it has been possible to estimate in monetary terms the benefits associated with improved measurement, comparatively expensive collection activities appeared to be a bargain (Hayami and Peterson, 1972; Savage, 1975). However, in most situations the diversity and volume of primary, secondary, and tertiary uses of census, survey, or registration data, and their use either alone or jointly with other data sets, do not permit any simple valuing of the benefits received. Also, the emphasis given at various times to the development of various data collection systems will depend in part on the existing ability of those systems to produce usable data. An informative discussion and bibliography appear in the NAS report Setting Statistical Priorities (National Academy of Sciences, 1976).

Second, although common sense should never be abandoned, there are a variety of technical issues involved in data collecting that must be taken into account fully when assessing collection plans and results. For many sampling problems the issues are more complex than common sense might suggest, and the resolution of these issues leads to unexpected consequences. For example, the sampling fraction in a population is less significant than the absolute size of the sample, except in cases where the sampling fraction is exceptionally high.

Third, all data collection activities are affected by errors that can and do occur at every stage of the collection process--during the design, field work, coding, editing, tabulation, estimation, and dissemination. Although random errors tend to cancel each other out, errors of bias do not necessarily tend to cancel each other (although undoubtedly there are cases where opposing biases lead to some canceling out).

Fourth, the possibility that errors of various types and magnitudes exist in some body of data does not render such data useless; it does, however, impose a responsibility on the producer of a given set of data to provide as much information as possible about the type and size of errors affecting it. The user of such data has a responsibility also: the limitations provided by the producer must be observed, and the quality of the data must be examined in light of the specific use to which it will be put.

Fifth, it is possible and important to reduce to acceptable levels errors in data used to measure fertility and mortality. The first step is to identify the causes and extent of errors; that is one purpose of this report. It is equally important to take action to reduce error to acceptable levels; frequently, but not always, appropriate actions are obvious from the knowledge about the source and type of error.

Sixth, a theme closely related to all of the above is that data quality is important and it can and should be improved. Data quality depends on both design and execution, probably more on the latter. The problem of execution, essentially the problem of effective management, is crucial to the attainment of high quality in statistical data collection. The lack of careful execution of data collection activities is one reason why money often fails to buy quality in demographic-measurement projects in developing countries.

Seventh, statistics are not a free commodity. The resources needed to maintain and improve data collection activities in developing countries may be substantial and as further demands are placed on the data in terms of detail, timeliness, and accuracy, the resources required also increase. By resources we mean primarily, but not exclusively, money. This includes money for the salaries of the staff (e.g., demographers and statisticians, field workers, clerical personnel), money for the purchase or rental of equipment (e.g., computers, duplicators, automobiles, typewriters), money for space, for supplies, and so on. Although such efforts are rarely cheap in absolute terms, the costs involved can reasonably be expected to be small in comparison to the cost of incorrect decisions made on the basis of unreliable data or in the absence of any data.

Establishing data collection operations that are national in coverage, or even making major efforts to upgrade such operations, also takes time. In addition, such operations require experienced and skilled personnel in a variety of disciplines, including, for example, biostatistics, cartography, data processing, demography, management of field operations, sampling, statistical administration. While to some extent money can "buy" time and needed personnel, the extent to which this is possible is often overestimated. In general, there is a direct relationship between the levels of socioeconomic development in countries and their ability to implement and maintain civil registration systems that register most vital events, although there are examples of poor countries with good CR/VS systems, e.g., Egypt and Tunisia.

Eighth, rational thinking about data collection essentially consists of examining a series of interrelated trade-offs about methods and procedures in light of both the uses to which the data will be put and the resources required to implement the methods and procedures. In the present context, one of the most important functions that statisticians can perform is to help users of fertility and mortality data become more knowledgeable about the trade-offs involved in collecting these statistics and to assist in the process of identifying and quantifying these trade-offs.

Finally, closely linked with trade-offs is the concept of the substitutability of data collection procedures. In some cases and for some purposes it is possible to substitute one data-collection process for another. One example is adding to the census questions on children ever born and children surviving in order to generate data that allow fertility and child mortality to be estimated using indirect estimation techniques, instead of conducting a special survey. This is possible provided, in this example, that there is prior knowledge concerning the adequacy of data generated by these questions, and that the assumptions of the indirect techniques to be applied are met. However, there are cases when user needs preclude substitution. For example, surveys usually cannot provide local area data; only censuses and vital registration systems can do so, and even in those systems special tabulation procedures frequently are required. Hence, substitution is worth considering, particularly in the context of advance planning and resource allocation, but its limitations should be recognized.

The next three chapters of this report describe the current state of the art in collecting data for the estimation of levels and trends of fertility and mortality. The emphasis is on how one identifies problems, successes, errors, lacunae, and so on, and on issues such as complementarity of data collection systems, costs, and trade-offs in design, execution, and long-range planning. This report does not, however, present a systematic set of recommendations on how to improve the collection of data for estimating fertility and mortality. A brief summary statement for administrators and policy makers interested in these matters is contained in a companion report by the Panel, Data Collection: A Statement for Administrators (National Research Council, 1981). A more technical treatment of some of the latest advances in the estimation of fertility and mortality is provided by another Committee publication, Indirect Techniques for Demographic Estimation (Hill et al., 1981).

REFERENCES

Bean, L. L. (1978) Discussion. In K. J. Krotki, ed., *Developments in Dual System Estimation of Population Size and Growth*, pp. 49-50. Edmonton: The University of Alberta Press.

Cochran, W. G. (1963) *Sampling Techniques* (2nd ed.). New York: John Wiley and Sons.

Deming, W. E. (1950) *Some Theory of Sampling*. New York: Wiley.

Eckler, A. R. (1970) Statisticians and shoemakers ("Who is worse shod than the shoemaker's wife?" from Heywood's proverbs). *Journal of the American Statistical Association* 65(329):9-21.

Eisenhart, C. (1969) Realistic evaluation of the precision and accuracy of instrument calibration systems. In H. H. Ku, ed., *Precision Measurement and Calibration*, Vol. 1, pp. 21-47. Washington, D.C.: U.S. National Bureau of Standards.

Gauss, K. F. (1809) *Werke 4*, 1-93. Gottingen.

Hansen, M. H., W. N. Hurwitz, and W. G. Madow (1953) *Sample Survey Methods and Theory* (Vol. I: *Methods and Applications*). New York: John Wiley and Sons, Inc.

Hayami, Y., and W. Peterson (1972) Social returns to public information services: Statistical reporting of U.S. farm commodities. *American Economic Review* 62(1):119-130.

Hill, K. H., H. Zlotnik, and J. Trussell (1981) *Indirect Techniques for Demographic Estimation*. Committee on Population and Demography, Assembly of Behavioral and Social Sciences, National Research Council, National Academy of Sciences. (To be published as Manual X in the series of manuals of demographic analysis of the Population Division, United Nations.)

Juster, T. F. (1974) The use of surveys for policy research. *American Economic Review* 64:355-364.

Kish, L. (1965) *Survey Sampling*. New York: John Wiley and Sons, Inc.

Leontief, W. (1971) Theoretical assumptions and nonobserved facts. *American Economic Review* 61(1).

Louwes, S. L. (1967) Cost allocations in agricultural surveys. *Review of the International Statistical Institute* 35:264-290.

Marks, E. S., W. Seltzer, and K. J. Krotki (1974) *Population Growth Estimation: A Manual of Vital*

Statistics Measurement. New York: The Population Council.

National Academy of Sciences (1976) *Setting Statistical Priorities*. Report of the Panel on Methodology for Statistical Priorities, Committee on National Statistics, National Research Council. Washington, D.C.: National Academy of Sciences.

National Research Council (1981) *Data Collection: A Statement for Administrators*. Panel on Data Collection, Committee on Population and Demography. Washington, D.C.: National Academy Press.

Rivlin, A. (1974) How can experiments be more useful? *American Economic Review* 64:346-354.

Savage, I. R. (1975) Cost-benefit analysis of demographic data. *Advances in Applied Probability--Supplement* 7:62-71.

Seltzer, W. (1972) PGE studies: Cost and effectiveness. In *Proceedings of the Social Statistics Section, 1971*, pp. 97-105. Washington, D.C.: American Statistical Association.

Seltzer, W. (1973) *Demographic Data Collection--A Summary of Experience*. New York: The Population Council.

Sirken, M., and P. Royston (1971) Reasons deaths are missed in household surveys of population change. In *Proceedings of the Social Statistics Section, 1970*, pp. 361-364. Washington, D.C.: American Statistical Association.

Stouffer, S. A. (1938) Problems of the Bureau of the Census in their relation to social science. In *Research--A National Resource*, pp. 197-231. Washington, D.C.: National Resources Committee.

Trussell, J., and E. Brown (1979) A close look at the demography of Afghanistan. *Demography* 16(1):137-156.

United Nations (1978a) Draft principles and recommendations for population and housing censuses. Mimeographed document, No. E/CN/3/515. New York: United Nations.

United Nations (1978b) Progress Report on the National Household Survey Capability Programme. Mimeographed document, No. E/CN/3/527. New York: United Nations.

United Nations (1978) *Demographic Yearbook, 1977*. New York: United Nations.

U.S. Bureau of the Census (1963) *United States Censuses of Population and Housing: 1960, Enumeration Time and Cost Study*. Washington, D.C.: U.S. Government Printing Office.

Wells, H. B., and D. G. Horvitz (1978) The state of the art in dual systems for measuring population change. In K. J. Krotki, ed., Developments in Dual System Estimation of Population Size and Growth, pp. 53-69. Edmonton: The University of Alberta Press.

2 The Census of Population

2.1 INTRODUCTION

This chapter reviews the state of the art of censuses of population with specific attention to the collection and use of census data for estimating fertility and mortality. It includes ten sections: definitions and the background of census-taking, census procedures and special problems, advantages and limitations of censuses as a data collection method; special relationships between censuses and sampling; the status of censuses in developing nations; measuring error in census data; using censuses to gather data on fertility and mortality, design issues and options; and a summary.

2.2 DEFINITIONS AND BACKGROUND

The United Nations (1980:2) defines a population census as the total process of collecting, compiling, evaluating, analyzing, and publishing or otherwise disseminating demographic, economic, and social data pertaining to all persons in a country or in a well-delimited part of a country at a specified time. A housing census is the comparable process relating to all living quarters and occupants thereof (see United Nations, 1980). Most modern censuses are combined censuses of population and housing.

In some countries the government compiles a list of villages, with counts of housing units and the number of persons in each unit. Such lists usually are designed to meet specific administrative purposes, including the collection of taxes. They should not be confused with population censuses, which seek information concerning

27. Extent of user services provided	Direct	Direct	Direct
28. Extent to which sampling is employed at the collection stage	Inverse	N.A.	N.A.
29. Extent to which automatic data-capture methods are used (e.g., FOSDIC, OCR, OMR; see Figure 2.3)	Unknown[s]	Unknown[s]	Unknown[s]
C. Factors Related to Accounting and Budget Practices (how costs are calculated and reported)			
1. Comprehensiveness of cost accounting procedures	Direct[t]	Direct[t]	Direct
2. Extent to which common infrastructure expenses are charged to the system's budget	Direct	Direct	Direct
3. Extent to which the system makes use of uncosted ("free") resources[u]	Inverse	Inverse	Inverse
4. Extent to which large, one-time capital expenditures are charged to the system's budget[v]	Direct	Direct	Direct
5. Rate of inflation during census or survey period	Varies[w]	Varies[w]	N.A.

Note: N.A. means not applicable.

[a] The total cost of any data collection system is a result of the joint impact of all the specified factors plus any unspecified factors that may also affect costs. The direction of the gross relationship indicated assumes that other factors (for example, quality and timeliness) are held constant.

[b] Aggregate costs tend to vary directly with population size. However, costs expressed on a per-capita or per-household basis tend to be relatively high for countries with very small populations.

[c] Although at the gross level costs are determined by the size and nature of the sample rather than the absolute size of the population, it is also true that in a larger population there may be greater interest in separate estimates for regions and other factors that relate population size to costs, e.g. distances to be traveled.

TABLE 1.7 (continued)

[d] Lower average household size implies more one- and two-person households; persons in such households generally are more difficult to locate, e.g. they are away from home more frequently, they may be more relutant to provide information, and they report on behalf of fewer people, which means that more questionnaires or forms must be filled out and processed per capita.

[e] Includes the comprehensiveness and efficiency of the transportation and communications systems as well as quality of address information.

[f] Includes the price and wage and salary system of the country.

[g] The absence of a continuing census organization (core staff and operations) during the intercensal period may tend to increase costs for many items at the time of the next census, especially the cost of trained senior staff, who may not be available (which can lead to quality problems). Also, the complete processing and tabulation of data from one census usually takes a number of years, and planning for the next census must start some years in advance of the census. Thus there is usually plenty of work for a core census staff during the intercensal period.

[h] Any saving from the existence of a sample survey organization depends on how intensively the organization is used.

[i] For example, if each enumerator is provided with a map of his or her individual enumeration area.

[j] In a general sense, the relationship is direct. However, if the total number of questions is not increased but simply divided among several shorter questionnaire forms, the cost may not increase, and it could actually decrease if there are subsequent savings at processing stages. Also, the direction of the relationship is affected by whether the separate questionnaires are used with different respondents in the household: if an interviewer must seek and interview an additional respondent for one of the questionnaires, the cost will increase.

[k] Although the marginal cost of adding any one precoded item is usually low, the cumulative impact of adding several items can be substantial. Moreover, the low marginal cost is often achieved by not altering the census or survey plan to take into account the added items. This, in turn, may result in trade-offs in terms of census coverage, the quality of responses obtained for other items, and respondent burden.

[l] The direction of the gross relationship between the existence of a permanent field organization and census costs is direct. However, the advantages (in terms of quality of personnel, the collection of intercensal data, etc.) should be considered.

[m] The direction of the gross relationship between the existence of an overall field organization to conduct surveys and survey cost is inverse. However, if only field workers are considered, the direction of the relationship will depend on the intensity of their use. In general, the need for salary payments between surveys and fringe benefits required for permanent government staff will outweigh savings on recruitment and training. However, other factors must be considered, including skill levels of available short-term personnel, the extent to which field staff can be used for coding and data processing activities, and the general level of government salaries.

[n] This assumes that the sampling error for the system remains constant; therefore, the relationship is between the number of PSUs and the cost for a given sampling error. In an ideal sample the number of PSUs is (in conjunction with cluster size) at an optimum, so that either an increase or a decrease in the number of PSUs will increase the cost for a given sampling error. See also footnote o.

[o] This assumes that work load considerations remain constant. However, frequently work load considerations are not constant as the number and average size of PSUs change, and these work load considerations can affect costs, e.g., travel time, number of interviews completed in a day, size of team than can be transported in available vehicles.

[p] The additional costs of more training and supervision may be partially offset by reduced costs at the processing stages. However, the principal gains achieved through more extensive training and supervision are likely to be improved coverage (in a census) and improved quality generally.

[q] Fertility histories are almost never used in a census, except in small samples within a census. In surveys the impact on costs is high at both the collection and the processing stages.

[r] As the cost of computing and programming time declines, this factor becomes less important.

[s] Too little evidence exists at this time to assess the impact.

[t] Particularly, the extent to which preparatory activities in the early stages of the census and other activities beyond the direct costs of the field work are covered by the census or survey budget.

[u] For example, the use of government-employed primary school teachers as enumerators, interviewers, or supervisors with either no or only modest supplementary payments for their activities.

[v] For example, the cost of a new computer or data-capture equipment.

[w] If a very high rate of inflation prevails, expenditures related to activities in the latter stages of the census or survey (for example, data processing) will be unduly high compared to those for activities in the earlier stages (for example, cartographic preparations) unless expenditures are expressed in real terms.

each individual in the specified area. Most countries have adopted the principle that information collected in the census should be used only for statistical purposes. These purposes may include the adoption of policies and programs that affect the rights, duties, or obligations of the population (including the respondents). However, the information supplied by the individual is not to be used to take action on that individual.

A census strives for completeness of coverage within defined boundaries. In principle, the data are collected at the same point in time, though the period of enumeration may in fact extend over some weeks or months. Current practice calls for the listing of each individual and for the provision of information about each, although in some cases the amount of information collected on each individual is very small; for example, the 1953 census in the People's Republic of China asked only name, age, sex, and nationality. Data collection efforts that produce only totals for a household, a village, or some other group of individuals are no longer considered adequate for the purposes for which a census is taken.

In principle, a census relates to a specific time unit: a day, a week, or some other period. However, many censuses also call for information relating to some time in the past; questions about births or deaths during the preceding year, or occupation during the preceding week, month, or year are frequently included. A longer time reference underlies questions on numbers of children ever born and surviving and questions about migration, during a fixed or indefinite period.

When governments wish to know how many people there are, how they are distributed over the national territory, how many there are in particular categories (such as men of military age or children of school age) and whether or not the population is growing, they turn to a census for the information. A count of the people has long been one of the early steps in any program of development, and newly established nations have turned to censuses as one of the first steps in their development programs. By 1980, only Ethiopia and a few smaller countries had not taken at least one census, and the great majority of countries and an even larger proportion of the world's population live in countries where more than one census has been carried out. A number of countries have had censuses at fairly regular intervals for a century or more.

Although a census is in effect a snapshot of a population at a given point in time, it also provides a basis for inferences concerning past and future changes. Comparison of censuses taken at different times provides information concerning growth or decline of the total population and of groups of people, as well as changes in sub-areas within the country. Analysis of the data can throw important light on changes that have taken place and also provide a basis for projections of future changes.

The importance of censuses for national and international programs has long been recognized. In the latter half of the nineteenth century, the International Statistical Institute undertook to develop standards and guidelines for census taking and to ensure a measure of comparability from one national census to another. An early activity of the United Nations was the promotion of census taking by member countries. Since the 1940s the Interamerican Statistical Institute has actively promoted the taking of censuses in the western hemisphere, developing standards and providing technical assistance. Regional offices established by the United Nations have made substantial efforts to support censuses in their regions. More recently, there have been significant international efforts to stimulate the conduct of censuses, especially in Africa, where a number of countries had not previously taken any census of population. It is anticipated that by 1985 there will be virtually no countries in the world that have not had at least one census.

2.3 PROCEDURES AND PROBLEMS IN CENSUS TAKING

The major purpose of most censuses is to establish how many people are residing within a defined area as of a stated time. The number of persons in a given sub-area may be established on the basis of actual physical presence (de facto) or on the basis of a legal or customary attachment to the area (de jure). In practice it may be difficult to adhere rigorously to either concept, and many censuses in fact represent a compromise between the two. Military personnel, migratory workers, guest workers, interns, university students, and in some countries secondary school students, nomads, and visitors are some of the individuals for whom special provisions must be made.

A person's eligibility for inclusion in a census may vary from one country to another. Although normally a census is totally inclusive, there are instances in which certain categories of people are omitted. These might be non-citizens who are presumed to be temporary residents, or they might be nomadic peoples or other groups that are especially difficult to enumerate. There is considerable variation in practice regarding domestic or foreign military personnel; sometimes censuses omit them entirely. Analysts of census data need to pay special attention to the criteria for inclusion in the count which were applied to the census in question.

Some of the most difficult problems in demographic measurement, which arise in CR/VS (civil registration or vital statistics) systems and surveys as well as in censuses, are the problems associated with the determination of residence and migration, especially internal migration. Even when counting and classification rules are clear and respondents understand such concepts as "usual resident," "visitor," "temporarily absent," "intent to stay," and "duration of stay," application of the rules can be a complex process, leading to undercounts and overcounts in censuses, failure to register vital events or, in rare cases, double registration, and to improper inclusion or exclusion of respondents in surveys.

Another decision that must be made in planning a census is whether to contact respondents directly (normally by having enumerators visit households) or to ask respondents to fill in forms themselves and return them to the census office. The latter approach is feasible only for countries in which literacy levels are reasonably high and in almost all cases must be supplemented by personal visits for missing and incomplete forms. The first approach involves direct personal reporting by the respondent (or respondents, if more than one person is providing information to the census interviewer) as well as indirect or proxy reporting on other members of the household. In general, direct reporting provides more accurate and complete information than proxy reporting (Hobcraft, 1980; Marckwardt, 1973; Tuygan and Cavdar, 1975; Madigan, 1973; Madigan and Herrin, 1973). With proxy reporting, however, costs are reduced, and there are fewer refusals because respondents tend to be the more cooperative members of households.

Combinations of the two reporting modes are commonly used in developed nations; personal visits to householders who may require assistance in filling out the form and follow-up visits to nonrespondents are essential elements in any census that relies primarily on census returns provided by householders. Most developing nations use the direct-contact method, which has the advantage of allowing the enumerator to verify the existence of the household being enumerated and often also the members of the household. It does not solve all data collection problems, however, since enumerators often need to probe for correct or additional information. Moreover, in many developing nations crucial items, especially those needed to estimate of fertility and mortality, are not known with precision, and errors by both enumerators and respondents occur.

Age is one such item. In some developing societies, such as Korea and Thailand, individuals know their birth dates and ages with considerable accuracy, while in many others, such as many countries of Africa and South Asia, age is known only within rather broad ranges. In the latter situations attempting to produce reasonable estimates of age can be a very frustrating experience for both the census enumerator and the respondent. In a technical sense, there is much room for interviewer and respondent bias and for interviewer and respondent error. In two countries, Morocco and Gambia, some census interviews were tape-recorded to study the sources of error in age reports (Quandt, 1973; Gibril, 1979). Morocco and Gambia are among the very few countries that have undertaken serious efforts to ascertain the reasons for and the ways in which age misreporting occurs, with the goal of improving the enumeration process in subsequent censuses. One finding in these and other studies is that ages for an entire household are frequently reported by a single individual who may not be in a good position to estimate all of the ages. Studies of the use of historical calendars, an interviewing tool designed to improve the accuracy of age reporting, indicate that this technique does not improve reporting significantly, even when interviewers bother to use it properly. A more complete review of the sources of age misreporting and the significance of it for data analysis is found in a study by Ewbank (1981).

Experience indicates that the most reliable way of conducting a census in most circumstances is to seek contact with the population at their places of residence. Requiring that people come to some central point to report the census information places additional burdens on them and is likely to lead to incompleteness. Special circumstances pertain in the case of nomads who have no fixed place of residence; the usual practice is to require them to assemble at some fixed point in their normal path of movement. The central-point method also causes particular problems for demographic surveys that use the census for local area data, or as a sampling frame, because it makes it difficult to identify the particular geographic location of each household, information needed for areal sampling. If a demographic survey sample is drawn by randomly selecting households from a census list obtained through central-point interviewing, the households selected usually will not be located near to one another, resulting in a very scattered sample. Also, such samples frequently are not up-to-date. A third method is to require all persons to remain all day long at home or wherever they happen to be (e.g., their workplace, a school, a bus station) on a day designated as "census day." Jordan and Turkey have used this method.

2.4 ADVANTAGES AND LIMITATIONS

Although the complete coverage provided by a census is an advantage in general, its corollary limit on the amount of detailed information that can be collected on each individual or household is a drawback for the purposes of collecting fertility and mortality data. The questions asked in censuses are necessarily limited in scope because of money costs and burden on the respondents, and because each additional question means much more data to process, even if sampling is utilized. Nevertheless, most censuses provide a great deal of information that can be used in estimating fertility and mortality.

As noted earlier, periodic censuses provide a basis for measuring changes in the total number, geographic distribution, and other characteristics of the population. In addition, censuses provide the essential denominator information needed to calculate crude birth and death rates and age-specific rates in countries where the civil registration/vital statistics systems can to provide the numerator information either directly or after adjustments for incomplete registration.

Even when only one census is available, significant information about fertility can be extracted from it. Size of household, the relationship of the number of young children to the number of women of childbearing age, and the relative size of age cohorts provide clues to the past as well as to the future. Information about the relationship of each child to the head of the household can serve as the basis for fertility estimates derived using the "own children" method of indirect estimation (see Cho, 1973; Hill et al., 1981).

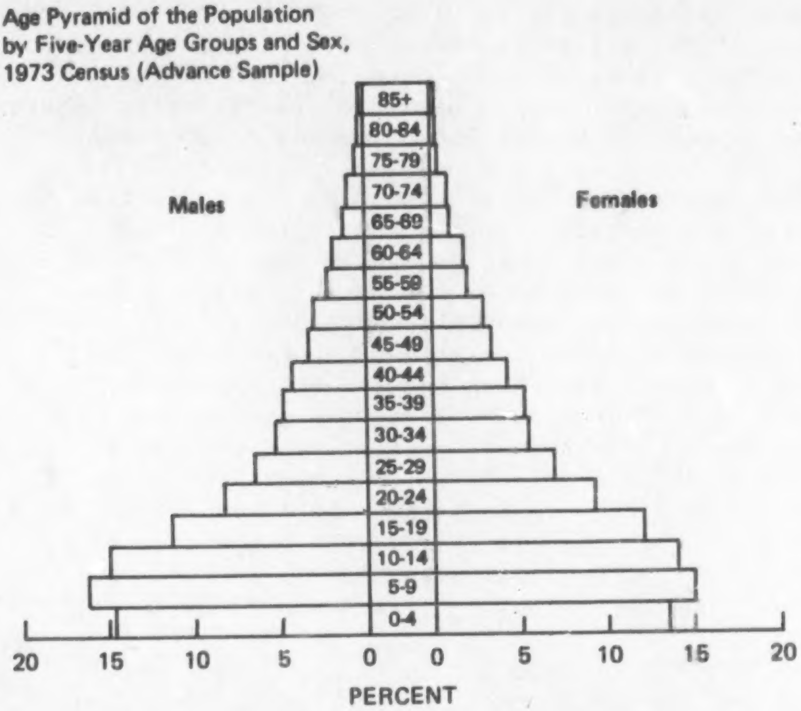
Recent changes in fertility can be discerned from the age structure revealed by a census if the age distribution is available for single years, if age misreporting is not a major factor or the age distribution can be reasonably adjusted, and if reasonable assumptions can be made about mortality patterns. Figure 2.1 shows the age structure for the 1973 census in Colombia, by five-year age groups. The single-year distribution is available; five-year groups are used here for simplicity. Note that the number of children aged 0 to 4 is less than the number aged 5 to 9, suggesting declining fertility. This suggestion of declining fertility requires an assumption that the extent of underreporting in the 0-4 age group is not severe.

Additional information on fertility is gained if census data include proportions married and duration of marriage. Another item useful in fertility analysis is the parity of the mothers of children born during the 12 months before the census.

More accurate estimates of both fertility and mortality--including age-specific fertility rates and estimates of the probability of dying by exact ages 2, 3, and 5--can be made from one census if data on children ever born and children surviving have been collected. This is possible even in situations where fertility and mortality are changing. (See Section 2.9 below and Appendix B.)

Successive population censuses can provide a good basis for estimating mortality as long as the population has not been subject to much migration or if such migration can be estimated with reasonable accuracy. By comparing the number of people in each age group present at one census with the number present at a subsequent census, one can calculate the survivorship rate of each age cohort alive at the first census. Before attempting such calculations, however, the data frequently must be adjusted to compensate for the effects of differential age misreporting across age groups.

Some censuses (and surveys) have included questions on the number of deaths in the household during a recent


Age Pyramid of the Population
by Five-Year Age Groups and Sex,
1973 Census (Advance Sample)

Source: Potter, J. E., M. Ordonez, and A. R. Measham (1976). The rapid decline in Colombian fertility. *Population and Development Review* 2(3):509-528.

FIGURE 2.1 Age Structure of Colombia, 1973

period or on whether the respondent's mother or father or (in the case of surveys) first spouse, is still living. In conjunction with information on age, responses to such questions on orphanhood and widowhood permit adult mortality levels to be estimated indirectly, using techniques developed in recent years (Brass and Hill, 1973; Hill and Trussell, 1977; Hill et al., 1981).

2.5 RELATIONSHIPS BETWEEN CENSUSES AND SAMPLING

As noted in Chapter 1, each of the major data collection methods has relative advantages over the others. By using censuses and sample surveys in combination, one can capitalize on the strengths of both methods. A census, by definition, strives for complete coverage of the population within the defined territory, which means that it can provide data for each of the subdivisions within the country. If only national figures are desired, a properly selected and well controlled sample survey may be adequate for the purpose in hand; surveys carried out with sufficiently large samples can provide regional estimates (see Chapter 4). Such surveys, however, should not be confused with full-scale censuses, nor with samples that are designed specifically to be used in conjunction with censuses.

Samples connected with censuses differ from other samples because of their double roots. They share methods with other samples, but their connection with censuses gives them special functions and special advantages in terms of funds and resources. For one thing, they are usually larger than samples not connected with censuses and often are large enough to produce statistics for moderately small areas. However, they also share the inflexibilities of censuses in timing and content. The four basic ways that samples and sampling techniques are used with censuses are shown in Figure 2.2, which also lists the primary purposes of each approach.

2.5.1 Samples Built into Censuses

Probably the most closely interrelated use of samples and censuses is the case of samples that are built in to a census: a sample of the census population responds to a set of special questions in addition to those on the standard census schedule. In censuses, each question is expensive because it is asked for every member of the population or for every household. Hence, census questionnaires are generally kept brief and simple (precoded or easily coded items) to save costs of collection, processing, and tabulation and to reduce the burden they place on respondents. However, more diverse and richer data are increasingly being obtained with samples built in to the census. The size of these "built-in" samples usually ranges from 1 percent to 25 percent of the census population. In most cases the absolute size of the sample and how it is selected are more important than the sampling fraction. Often the sample questionnaire contains the regular questions of the census and the special questions, so that a single visit to each unit suffices.

One of the primary advantages of built-in samples is that they generally include more persons than could be

FIGURE 2.2 The Purposes Served by Associating Samples with Censuses

---

1. Samples Built into Censuses
    - a. Obtaining richer data
    - b. Reducing costs of collection and tabulation
    - c. Reducing social burden (longer interviews required only from a small part of the population)

2. Samples Added to Censuses
    - a. Evaluating quality of census data
    - b. Checking coverage of census
    - c. Obtaining dual coverage
    - d. Establishing a base for continuing sample surveys
    - e. Providing quality control of individual enumerators
    - f. Investigating methods and questions prior to the census (pretesting)

3. Sampling from Census Data
    - a. Early tabulation and release of data (preliminary results)
    - b. Checking quality of editing and processing
    - c. Reducing costs of complex analysis
    - d. Generating public-use tapes for deeper analysis

4. Census as Auxiliary Data for Samples
    - a. Providing data for sample selection (e.g., measures of size, stratification, mapping, and seldom names or addresses)
    - b. Providing data for improved estimation (ratio, regression, analysis, etc.)

---

included in independent sample surveys. The larger sample size facilitates analysis of differences within the country, such as those among regions, between rural and urban residents, or among persons in different occupational or other socioeconomic groups.

Another advantage of built-in samples is that they facilitate more detailed analysis. Relating information about fertility collected from a built-in sample to some of the characteristics normally included in the census questionnaire provides a relatively efficient basis for analyzing the effect on fertility of such factors as education, occupational and industrial activity, rural-urban residence, membership in ethnic or linguistic groups, etc., provided that the tabulations are prepared in appropriate combinations.

Procedures for selecting a built-in sample vary. Households may be used as sampling units in order to spread the sample widely, but bias seems unavoidable in such cases to the extent that individual enumerators are given responsibility for selecting households. For that reason, sample selection should not be left to enumerators but controlled centrally. Enumeration areas (EAs), which are sometimes referred to as enumeration districts, may be used also, or even larger units such as administrative districts, especially if the distinction between the special sample (with its longer questionnaire) and the full census (shorter questionnaire) needs special explanations and public relations efforts. The use of EAs or larger units makes it possible to provide special training for enumerators who will administer the longer forms used in sample areas. Such training is especially necessary in collecting high-quality data on fertility and mortality, or on nuptiality.

Including a built-in sample in a census operation does complicate the process, a fact that is not trivial and should be weighed carefully in any decision to use built-in samples. A general rule that holds for censuses conducted in developing nations is that adding complexity to field operations may jeopardize the entire data collection effort. The greater the complexity of the census field operations, the greater is the possibility that the census will collect poor-quality data. This is a general problem, although the level of data quality also depends strongly on the quality of enumerators. Problems in implementing the questionnaire at the enumerator level can also lead to subsequent analysis dilemmas. For example, if in theory there is a 5-percent sample but the result obtained is only 4.5 percent of the total count, should the data be adjusted, and if so, which set: the sample or the total population count? Countries that have experienced such problems with built-in samples of censuses include the Philippines, South Korea, and Ghana. In general, a census is usually better on coverage than a well-conducted sample survey.

Difficulties can arise in using census EAs as sampling units. Enumeration districts have two functions when used in censuses: they partition the area the population lives in with clear and identifiable boundaries, which facilitates its complete and unique coverage; they also help establish equal and feasible workloads for enumerators. Because these two aims are often in conflict, compromises are usually necessary. In addition, enumeration areas are often used for built-in samples in connection with censuses as well as for sample surveys carried out entirely separately. (In separate surveys they are often subsampled to yield clusters of desired sizes.) Enumeration areas are also small enough that they can be aggregated to construct sub-areas of cities or rural districts to be used for analysis, for example, census tracts, voting precincts and neighborhood areas.

The populations of EAs are compact and hence relatively homogeneous. The effects inherent in this homogeneity are increased by the response variance, since each EA usually is enumerated by a single interviewer, who adds the effects of his or her own interviewer bias. These effects may influence items that are crucial for estimating fertility and mortality, such as age or intervals between births.

2.5.2 Samples Added to Censuses

Like built-in samples, samples added to censuses are often planned in close conjunction with the census. Typically, however, they are conducted separately from the census and are usually smaller than built-in samples; the sampling fractions may range from 1/100 down to 1/1,000 or even 1/10,000. The items included may be different from those in the census schedule or may duplicate some or all of the items asked in the complete census or in the built-in sample. In the latter case, the sample added to a census can be used to evaluate the quality of census data, and to check the census coverage.

Among the most common forms of samples added to censuses are post-enumeration surveys (PES), which are generally used to check the quality of the census both in terms of completeness of enumeration and consistency of responses. This can be particularly useful in collecting data on items such as children ever born and children surviving. One approach to conducting a PES is to give PES enumerators the census reports for the sample they are reinterviewing and to have them reconcile the data they collect with the data in the census reports in order to improve the estimates. In another approach, PES enumerators are not given the census reports, in an effort to ensure "independence" between the PES and census observations. The same sample can be designed to include both coverage and content checks, or separate samples can be used for each purpose. Quality control and correcting the work of individual enumerators (i.e., details of the management of data collection) are separate issues that are discussed in Chapter 4.

Another form of samples added to censuses are pre-census sample surveys designed to pretest census items and procedures and provide training for census enumerators and supervisors. A census can be used also as a base for continuing sample surveys.

2.5.3 Sampling from Census Data

Another way to combine the sample and census methods is to apply sampling techniques to the body of data collected by the census. This approach is used in two major ways: (1) a sample set of data can be used to create preliminary tabulations, which can be made available before all the data have been processed; and (2) tabulations based on random sampling of census data can reliably be substituted for complete tabulations for some items in the interests of cutting costs. This kind of sampling is typically applied to data stored in census records, microfilms, and tapes. When early tabulation and release of census results is a priority, it is convenient to process initially the data from a selection of entire EAs or even entire administrative districts, in accord with the timing and flow of returns from the field. Such preliminary processing may also be helpful in checking the quality of editing and processing in the census office.

On the other hand, samples using households as the sampling unit are usually preferred for more complex analyses of census data, and especially for preparing tapes for public use. Spreading the sample often greatly reduces the level of the sampling errors. For most uses, it is preferable to select households rather than individuals because that approach provides samples of both of these populations. The clustering of individuals in households matters little in deeper analyses that do not utilize more than one member of the same household, and for some types of analysis multiple members are essential--for example, in applying the own-children technique of fertility estimation (see Cho, 1973; Hill et al., 1981).

Some countries, including Ecuador and Tunisia in recent years, have sampled complete-enumeration census data by household to produce tabulations on marital status, parity, and surviving children. Turkey used a 1-percent sample of households to produce preliminary tabulations of its 1975 census.

2.5.4 Using Census Data for Samples

Another way in which censuses and sample surveys are linked is by using a census as the frame from which samples are drawn for subsequent inquiries. The frame can provide the basis for selecting samples of areas or households. Good samples often are based on census data, which can provide measures of size for stratification and PPS sampling (sampling with probabilities proportionate to measures of size), information needed for stratification, and the details needed for maps of sampling units, such as EAs. Names of respondents usually are not provided to potential users of census data because of efforts to insure confidentiality and because of obsolescence caused by migration, the creation of new households, and changes in household composition. Census data can also be used to improve statistics by making it possible to calculate ratio and regression estimates.

2.6 THE STATUS OF CENSUSES IN DEVELOPING NATIONS

Table 2.1 summarizes the recent census experience of 95 countries in developing regions of the world, all of which were estimated to have populations of one million or more in mid-1980. In addition to information on past censuses (especially in terms of the availability and quality of age-sex data), the table indicates the prospects for 1980-round censuses (defined by the U.N. as 1975-84). The countries selected contain about 96 percent of the total population of Africa, Asia, and Latin America, which are defined as follows: Africa comprises the entire African continent and Madagascar; Asia includes all of Asia except Japan, Israel, and the Asian areas of the U.S.S.R.; Latin America is comprised of all of Central and South America including the Caribbean. The primary sources of the data in the tables are the U.N. Demographic Yearbook and the Population and Vital Statistics Report of the United Nations Statistical Office, showing data available as of 1 January 1981.

Table 2.2, a summary of census information published by the United Nations in 1974, shows the number of countries in the world that held a national census during the decades centering on 1950, 1960, 1970, and 1980.

The number of countries taking censuses has been increasing slowly over the past two decades. In the 1960 round (defined by the U.N. as 1955-64), 64 of the 95 countries identified in Table 2.1 undertook a census; during the 1970 round this number increased slightly, up to 69 of the 95. If current expectations for the 1980 round are realized, 86 of the 95 countries will hold a census (49 reportedly already have).

Generally Latin America has the best record of these three regions concerning frequency of censuses and availability of data, followed by Asia and Africa in that order. In mid-1980, about 45 percent of the African population resided in 17 countries that either had taken their first census during the period 1975-84 (13 countries), had never taken a census (3 countries) or had not had a census of acceptable quality during the preceding 25 years (1 country).

Column 3 of Table 2.1 indicates whether the census taken was complete ("C") or partial ("UR"). Nearly all the countries listed have conducted complete censuses. The number of first censuses ("C*")is particularly high in Africa, including 15 countries that conducted their first census in the 1970s.

If census data are to be of value for analytical purposes, they not only must be of adequate quality but the information generated must be made available to users. Normally, census data are prepared in the form of printed tabulations, but increasingly they are being made available in the form of computer tapes, especially in countries with advanced computing capabilities. Although these two requirements--adequate quality and data availability--may seem obvious, they often are not met, particularly in Africa. For example, in a recent Nigerian census, competition among different regions for representation in government resulted in accusations of false population counts, after which the government officially rejected the census (the chief of state declared the census null and void, and not to be used for planning purposes). Ironically, this occurred because the population had an all-too-clear understanding of the importance of the census and the benefits of a high count.

Problems with census-taking in less developed countries (LDCs) are widespread and can be cited in

TABLE 2.1 Type, Quality, and Availability of Data from Recent Censuses and Status of Census for 1980 Round: 95 Developing Nations with Estimated Mid-1980 Population of 1 Million or More, by Region

				Extent of Age Misreporting and Underenumeration			Availability of Census Data			
Region, Country or Area	Estimated Pop. in Mid-1980 (millions)	Year of Census	Type of Census[a]	U.N. Age-Sex Accuracy Index	Meyers Index of Age Heaping	Estimated % Under-enumeration	Age Dist. By Sex[b]	Age Dist. by Urban/Rural Residence[b]	Avail. of Census Schedule[c]	Status of Census for 1980 Round[d]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Africa										
Algeria	19.0	1960	C	--		--	--	--	--	X
		1966	C	38	7.6	--	UN 70	UN 70	Q	
		1977	C	--		3.4	--	--	Q	
Angola	6.7	1960	C	47	--	--	UN 70	--	--	2/83
		1970	C	60	--	--	A	--	--	
Benin	3.6	1979	C*	--	--	--	--	--	Q	X
Burundi	4.5	1979	C*	--	--	--	--	--	--	X
Cameroon	8.5	1976	C*	38	--	6.9,7.4	UN 78	UN 78	Q	X
Central African Republic	2.2	1975	C*	--	--	--	--	--	Q	X
Chad	4.5	None	--	--	--	--	--	--	--	NE**
Congo	1.6	1974	C*	45	--	--	A	--	Q	(1984)
Egypt	42.1	1960	C	53	66.4	--	UN 70	UN 70	--	X
		1966	C	--	--	--	--	--	--	
		1976	C	49	--	--	A	A	Q	
Ethiopia	32.6	None	--	--	--	--	--	--	--	(1982/1983)
Ghana	11.7	1960	C	49	15.6	2.5	UN 70	UN 70	--	3/82**
		1970	C	40	15.2	1.6	UN 72	--	Q	
Guinea	5.0	1972	C*	--	--	--	--	--	Q	2/81**
Ivory Coast	8.0	1975	C*	59	--	--	UN 77	UN 77	Q	X
Kenya	15.9	1962	UR	49	19.4	--	UN 70	--	--	X
		1969	C	33	13.4	--	UN 72	UN 73	Q	
		1979	C	--	--	--	--	--	--	
Lesotho	1.3	1956	C	--	--	--	UN 70	--	--	X
		1966	C	57	6.4	--	UN 70	--	Q	
		1976	C	--	--	--	--	--	Q	
Liberia	1.9	1962	C*	57	21.6	--	UN 70	--	--	(1984)
		1974	C	62	--	11.0	UN 78	--	Q	

Libya	3.0	1964	C	44	--	--	UN 70	UN 70	--	(1983)
		1973	C	45	--	--	UN 75	UN 75	Q	
Madagascar	8.7	1974-75	C*	--	--	--	--	--	Q	X
Malawi	6.1	1966	C	47	--	--	UN 70	--	Q	X
		1977	C	--	--	--	--	--	Q	
Mali	6.6	1976	C*	--	--	--	--	--	Q	X
Mauritania	1.6	1976	C*	--	--	--	--	--	--	X
Morocco	21.0	1960	C*	157	42.3	--	UN 70	UN 70	--	1981**
		1971	C	96	22.2	5.9	UN 72	UN 72	Q	
Mozambique	10.3	1960	C	45	--	--	UN 70	--	--	X
		1970	C	52	--	--	UN 77	--	--	
		1980	C	--	--	--	--	--	--	**
Namibia	1.0	1960	C	29	--	--	UN 70	UN 70	--	NE
		1970	C	--	--	--	--	--	--	
Niger	5.5	1977	C*	--	--	--	--	--	Q	X
Nigeria	77.1	1963	C	109	28.0	--	UN 70	UN 70	--	E
		1973	C	--	--	--	--	--	Q	
Rwanda	5.1	1978	C*	--	--	--	--	--	Q	X
Senegal	5.7	1976	C*	19	--	--	UN 77	--	Q	X
Sierra Leone	3.5	1963	C*	71	--	5.0	UN 70	--	--	(1984)
		1974	C	53	--	10.0	UN 77	--	Q	
Somalia	3.6	1975	C*	--	--	--	--	--	--	X
S. Africa	28.4	1960	C	23	--	7.0	UN 70	UN 70	--	X
		1970	C	11	8.6	2.6	UN 76	UN 76	Q	
		1980	C	--	--	--	--	--	--	
Zimbabwe	7.4	1961-62	C*	--	--	--	UN 70	--	--	E
(S. Rhodesia)		1969	C	59	8.1	4.2	UN 70	UN 70	Q	
Sudan	18.7	1955-56	UR*	--	--	--	UN 78-H	--	--	11/82**
		1973	C	67	--	4.8	A	--	--	
Tanzania	18.6	1957	C	--	--	5.4,6.3	UN 70	--	--	X
		1967	C	66	17.4	--	UN 72	UN 72	Q	
		1978	C	--	--	--	--	--	--	
Togo	2.5	1958-60	C*	66	16.4	--	UN 70	UN 70	--	3/81**
		1970	C	70	14.2	--	UN 77	--	Q	
Tunisia	6.5	1956	C	--	--	--	UN 70	--	--	
		1966	C	30	7.2	2.7-4.0	UN 70	UN 70	Q	X
		1975	C	30	--	--	A	A	Q	
Uganda	13.7	1959	C	102	23.6	--	UN 70	--	--	X
		1969	C	49	15.0	--	UN 72	UN 72	Q	
		1980	C	--	--	--	--	--	--	
Upper Volta	6.9	1975	C*	--	--	--	--	--	Q	X
Zaire	29.3	None	--	--	--	--	--	--	--	E**

TABLE 2.1 (continued)

Region, Country or Area	Estimated Pop. in Mid-1980 (millions)	Year of Census	Type of Census[a]	Extent of Age Misreporting and Underenumeration: U.N. Age-Sex Accuracy Index	Extent of Age Misreporting and Underenumeration: Meyers Index of Age Heaping	Extent of Age Misreporting and Underenumeration: Estimated % Under-enumeration	Availability of Census Data: Age Dist. By Sex[b]	Availability of Census Data: Age Dist. by Urban/Rural Residence[b]	Availability of Census Data: Avail. of Census Schedule[c]	Status of Census for 1980 Round[d]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Zambia	5.8	1963	C*	--	--	--	UN 70	UN 70	--	X
		1969	C	73	7.4	2.1	UN 72	--	Q	
		1980	C	--	--	--	--	--	--	
Total African Population	472.0									
Asia										
Afghanistan	15.9	1979	C*	--	--	--	--	--	Q	X
Bangladesh	90.6	1961	C	69	--	--	A	--	--	2/81
		1974	C	57	34.7	6.4	UN 78-H	UN 78-H	Q	
Bhutan	1.3	1969	C*	--	--	--	--	--	--	NE
Burma	34.4	1973	C	--	--	--	--	--	--	1983
Kampuchea	6.0	1962	C	18	--	--	UN 70	UN 70	--	NE
China (PRC)	975.0	1953	C	--	--	0.1	--	--	--	7/82
Hong Kong	4.8	1961	C	37	1.8	0.6	UN 70	UN 70	--	2/81-3/81
		1966	S	38	1.5	--	A	--	--	
		1971	C	37	2.8	1.1	UN 73	--	Q	
		1976	S	43	--	0.4	UN 78-H	--	--	
India	676.2	1961	C	51	31.1	2.8	UN 70	UN 70	--	3/81
		1971	C	39	32.8	1.7,2.7	UN 72	UN 73	Q	
Indonesia	144.3	1961	C	78	--	--	UN 70	UN 70	--	X
		1971	C	53	24.7	2.0,6.9	UN 75	UN 75	Q	
		1980	C	--	--	--	--	--	--	
Iran	38.5	1956	C*	--	--	7.5	UN 70	UN 70	--	X
		1966	C	68	23.6	5.0	UN 70	UN 70	Q	
		1976	C	51	--	3.0	UN 78	UN 78	Q	

Iraq	13.2	1957	C	51	--	--	UN 70	UN 70	--	X
		1965	C	41	22.3	--	UN 70	UN 70	Q	
		1977	C	--	--	--	--	--	Q	
Jordan	3.2	1961	C*	34	--	4.3	UN 70	UN 70	--	
		1979	C	--	--	--	--	--	--	X
Korea, N.	17.9	None	--	--	--	--	--	--	--	NE
Korea, S.	38.2	1955	C	34	1.1	--	UN 70	--	--	X
		1960	C	27	2.1	2.0	UN 70	UN 70	--	
		1966	C	26	0.8	2.9	UN 70	UN 70	--	
		1970	C	28	1.5	5.2	UN 73	UN 73	Q	
		1975	C	23	2.0	5.7	UN 77	UN 77	Q	
		1980	C	--	--	--	--	--	--	
Kuwait	1.3	1957	C*	123	--	--	UN 70	--	--	X
		1961	C	--	--	--	UN 70	--	--	
		1965	C	117	--	--	UN 70	--	--	
		1970	C	94	--	--	UN 72	--	--	
		1975	C	58	--	--	UN 75	--	--	
		1980	C	--	--	--	--	--	--	
Laos	3.7	None	--	--	--	--	--	--	--	(1984)**
Lebanon	3.2	None	--	--	--	--	--	--	--	NE
Malaysia	14.0	1957	C	33	8.0	--	UN 70	--	--	X
		1960	C	51	19.0	--	UN 70	UN 70	--	
		1970	C	28	--	4.7	UN 73	UN 73	Q	
		1980	C	--	--	--	--	--	--	
Mongolia	1.7	1956	C	39	--	--	UN 70	--	--	X
		1963	C	--	--	--	--	--	--	
		1969	C	--	--	--	--	--	--	
		1979	C	--	--	--	--	--	--	
Nepal	14.0	1961	C	56	--	--	UN 70	UN 70	--	6/81
		1971	C	53	--	4.9	UN 73	UN 73	Q	
Pakistan	86.5	1961	C	53	--	--	UN 70	UN 70	--	3/81
		1972	C	--	--	6.3	--	--	Q	
Philippines	47.7	1960	C	33	10.0	--	UN 70	--	--	X
		1970	C	24	--	0.3,1.9	UN 73	UN 73	Q	
		1975	C	--	--	--	--	--	--	--
		1980	C	--	--	--	--	--	--	--
Saudi Arabia	8.2	1962-63	C	--	--	--	--	--	--	NE
		1974	C	--	--	--	--	--	--	
Singapore	2.4	1957	C	34	2.4	--	UN 70	--	--	X
		1970	C	26	2.1	--	UN 70	--	Q	
		1980	C	--	--	--	--	--	--	
Sri Lanka	14.8	1963	C	29	14.1	1.0	UN 70	UN 70	--	3/81
		1971	C	26	8.7	1.0	UN 78-H	UN 78-H	Q	

TABLE 2.1 (continued)

Region, Country or Area	Estimated Pop. in Mid-1980 (millions)	Year of Census	Type of Census[a]	Extent of Age Misreporting and Underenumeration			Availability of Census Data			Status of Census for 1980 Round[d]
				U.N. Age-Sex Accuracy Index	Meyers Index of Age Heaping	Estimated % Under-enumeration	Age Dist. By Sex[b]	Age Dist. by Urban/Rural Residence[b]	Avail. of Census Schedule[c]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Syria	8.6	1960	C*	66	24.0	6.0	UN 70	UN 70	--	1981**
		1970	C	34	13.9	--	UN 73	UN 73	Q	
Taiwan	17.8	1956	C	45	1.7	0.1	UN 70	--		1980
		1966	C	39	--	1.0	UN 70	--		
		1970	S	37	1.5	0.4	A	--		
		1975	S	38	1.4	0.3	A	--		
Thailand	47.3	1960	C	19	2.4	4.0	UN 70	--	--	X
		1970	C	18	1.4	2.0,6.6	UN 73	UN 73	Q	
		1980	C	--	--	--	--	--	--	
Turkey	45.5	1955	C	67	32.3	--	UN 70	--	--	X
		1960	C	71	30.7	--	UN 70	UN 70	--	
		1965	C	53	17.2	--	UN 70	--	Q	
		1970	C	53	19.9	--	UN 72	--	Q	
		1975	C	35	--	1.2	UN 76	--	Q	
		1980	C	--	--	--	--	--	--	
Vietnam	53.3	1960	C	--	--	--	UN 70	--	--	X
		1974	C	--	--	--	--	--	--	
		1979	C	--	--	--	--	--	--	
Yemen (Aden)	1.9	1973	C	75	--	--	UN 74	UN 78-H	--	NE
Yemen (San'a)	5.6	1975	C	--	--	--	--	--	--	X
Total Asian Population	2,563.0									
Latin America										
Argentina	27.1	1960	C	12	1.1	3.6,4.4	UN 70	--	--	X
		1970	C	10	0.9	--	UN 73	--	Q	
		1980	C	--	--	--	--	--	--	
Bolivia	5.3	1950	C	46	21.0	8.4,10.4	UN 70	--	--	X
		1976	C	31	--	4.2,7.8	UN 77		Q	

Brasil	122.0	1960	C	19	9.1	--	UN 78-H	UN 78-H	--	X
		1970	C	11	5.1	3.1	UN 73	UN 73	Q	
		1980	C	--	--	--	--	--	--	
Chile	11.3	1960	C	16	6.5	3.8,5.4	UN 70	UN 70	--	4/82**
		1970	C	14	5.2	4.8	UN 72	UN 72	Q	
Colombia	26.7	1964	C	31	8.4	3.3	UN 70	UN 70	--	E
		1973	C	32	8.4	9.4	UN 77	--	Q	
Costa Rica	2.2	1963	C	25	5.6	3.3	UN 70	UN 70	--	5/83
		1973	C	21	5.1	0.4	UN 74	UN 74	Q	
Cuba	10.0	1953	C	34	--	--	UN 70	--	--	1981
		1970	C	23	--	--	UN 72	UN 72		
Dominican Rep.	5.4	1960	C	52	13.4	3.8	UN 70	UN 70	--	1981**
		1970	C	41	12.8	6.4	UN 72	UN 74	Q	
Ecuador	8.0	1962	C	35	15.0	--	UN 70	UN 70	--	6/83
		1974	C	26	--	2.5	UN 76	UN 76	Q	
El Salvador	4.8	1961	C	34	13.7	5.0	UN 70	UN 70	--	NE**
		1971	C	26	10.3	3.6	UN 72	UN 72	Q	
Guatemala	7.0	1964	C	28	9.8	3.5	UN 70	UN 70	--	3/81
		1973	C	28	11.1	9.5	UN 74	UN 74	Q	
Haiti	5.8	1950	C*	53	22.2	7.7, 8.3	UN 70	--		8/81
		1971	C	38	12.7	8.4	UN 78-H	UN 78-H	Q	
Honduras	3.8	1961	C	24	8.7	6.0	UN 70	UN 70	--	3/82
		1974	C	27	6.0	12.5	UN 77	UN 77	Q	
Jamaica	2.2	1960	C	25	5.4	0.9	UN 70	UN 70	--	5/81**
		1970	C	21	--	4.6	UN 73	--	Q	
Mexico	68.2	1960	C	26	13.0	4.0	UN 70	UN 70	--	X
		1970	C	19	8.5	2.4	UN 72	--	Q	
		1980	C	--	--	--	--	--	--	
Nicaragua	2.6	1963	C	39	14.8	--	UN 70	UN 70	--	1982
		1971	C	31	14.0	3.8	UN 74	UN 74	Q	
Panama	1.9	1960	C	17	4.0	0.8	UN 70	UN 70	--	X
		1970	C	14	3.3	1.3	UN 73	--	Q	
		1980	C	--	--	--	--	--	--	
Paraguay	3.3	1962	C	27	5.6	--	UN 70	UN 70	--	7/82
		1972	C	27	4.0	9.9	UN 75	UN 75	Q	
Peru	17.6	1961	C	25	9.3	--	UN 70	UN 70	--	6/81**
		1972	C	22	6.5	3.9,4.9	UN 78-H	UN 78-H	Q	
Puerto Rico	3.5	1960	C	30	3.8	--	UN 70	UN 70	--	X
		1970	C	17	--	--	UN 72	UN 72	--	
		1980	C	--	--	--	--	--	--	
Trinidad and Tobago	1.2	1960	C	23	--	--	UN 70	UN 70	--	X
		1970	C	28	--	8.4	UN 78-H	--	--	
		1980	C	--	--	--	--	--	--	

TABLE 2.1 (continued)

				Extent of Age Misreporting and Underenumeration			Availability of Census Data			
Region, Country or Area	Estimated Pop. in Mid-1980 (millions)	Year of Census	Type of Census[a]	U.N. Age-Sex Accuracy Index	Meyers Index of Age Heaping	Estimated % Under-enumeration	Age Dist. By Sex[b]	Age Dist. by Urban/Rural Residence[b]	Avail. of Census Schedule[c]	Status of Census for 1980 Round[d]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Uruguay	2.9	1963	C	16	2.3	1.7	UN 70	UN 70	—	X
		1975	C	16	1.8	2.1	UN 78	UN 78	Q	
Venezuela	13.9	1961	C	19	3.8	5.5,5.8	UN 70	UN 70	--	10/81-11/81
		1971	C	20	--	4.6	UN 78-H	--	Q	
Total Latin American Population	360.0									

Notes: Dash in column means not applicable or not available.

Mid-1980 pbpulation (column 1) is taken from the Population Reference Bureau's 1980 World Population Data Sheet. Unless otherwise noted, the U.N. Age-Sex Accuracy Index (column 4) for countries in Africa and Asia has been calculated from the age-sex distribution indicated in column 7. For countries in Latin America, the values for U.N. Age-Sex Accuracy Index (column 4) and Myers Index (column 5) are from Kamps (1976), unless otherwise noted. The Myers Index values obtained from OECD and Kamps were divided by 2 to conform with the formula in Shryock and Siegel (1973:207) used to calculate all other Myers values in the table.

Additional information on some countries is provided below. The census questions are referred to by column number.

[a]Column 3:
C = Complete census.
C* = First census ever taken.
UR = Full enumeration of urban areas with sample of rural areas.
S = Sample census.

[b]Columns 7 and 8:
UN (year) = First issue of U.N. Demographic Yearbook (1970 and later) to include specified age distribution. (UN 78-H indicates the Historical Supplement to UNDY 1978.)
A = Available in other source (see notes below).

[c]Column 9:
Q = Questionnaire available. (Unless otherwise noted below, questionnaire is on file at the U.N. Statistical Office.)

[d]Column 10:
X = 1980 round has been taken.
DATE = Projected date.
(DATE) = Census date anticipated by the U.N. Statistical Office, based on established pattern.
** = Indicates that current plans for a census in the 1980 round reflect a delay from previous plans.
E = A census in the 1980 round is expected, but there is no established pattern with which to estimate a date.
NE = No basis for expecting a census in the 1980 round.

AFRICA

Algeria 1960: (7) Broad age groups from a post-censal survey available in UNDY 1965, Table 6. 1966: (4) Ohadike and Tesfaghiorghis, 1975, p. 23. (5) UNDY 1971. 1977: (6) WP 79.

Angola 1960: (7) Ages 0-1 not shown. 1970: (7) For black population only, OBCD.

Cameroon 1976: (3) WP 77 refers to this enumeration as a "survey" as well as a "census." (6) Low figure from WP 79; high figure from PVSR, 1 Jan. 80.

Chad An "administrative" census was conducted in March 1968.

Congo 1974: (7) OBCD.

Egypt 1960: (5) Cairo Demographic Centre, 1970, pp. 252-253. Myers Index shown is for females; males = 50.4. 1976: (7) and (8) Available from CAPMAS.

Ghana 1960: (4) USBC. (5) UNDY 1962. (6) USBC. 1970: (4) USBC. (5) UNDY 1973. (6) USBC.

Ivory Coast 1975: (7) Ages 0-1 not shown.

Kenya 1962: (4) USBC. (5) UNDY 1971. (7) Ages 0-1 not shown. 1969: (4) USBC. (5) UNDY 1971. (6) Officially reported total includes an adjustment for underenumeration (USBC). (8) Broad age groups over age 30.

Lesotho 1956: (4) Data by broad age groups in UNDY 1970. (6) Census thought to be highly underenumerated (WP75). 1966: (5) OBCD. Myers Index shown is for females; males = 6.8. (7) Ages 0-1 not shown.

Liberia 1962: OBCD. Myers Index shown is for females; males = 17.9. 1974: (6) WP79. (7) Ages 0-1 not shown.

Libya 1964: (4) Ohadike and Tesfaghiorghis, 1975, p. 23.

Madagascar 1974-75: (3) Census conducted 12/1/74-6/1/75 (WP77).

Malawi 1966: (7) Ages 0-1 not shown.

Mauritania 1976: (7) and (8) Distribution of population by broad age groups but not by sex available in UNDY 1978-Historical Supplement.

Morocco 1960: (5) UNDY 1963, Myers Index shown is for females; males = 38.4. 1971: (5) UNDY 1973. (6) WP79.

Mozambique 1960: (7) Ages 0-1 not shown. 1970: (4) OBCD.

Namibia 1960: (7) Ages 0-1 not shown.

TABLE 2.1 (continued)

Nigeria 1963: (3) The 1962 census was rejected and the 1963 census is thought to have been highly overenumerated (Caldwell, Okonjo, ed., 1968, pp. 5-6). (5) OECD. Myers Index shown is for females; males = 26.7. 1973: (3) Census results rejected because of overenumeration (Lagos Daily Times, May 13, 1978, p. 21).

Senegal 1976: (4) OECD. (7) Ages 0-1 not shown.

Sierra Leone 1963: (6) UNDY 1970, Table 6. (7) Ages 0-1 not shown. 1974: (6) Official total includes adjustment for underenumeration (WP75; PVSR, April 1978). (7) Ages 0-1 not shown.

South Africa 1960: (6) Implied by comparison with official mid-year estimate (WP77). 1970: (5) UNDY 1973. (6) WP77. (7) and (8) Broad age groups over age 55.

Sudan 1955-56: (3) Sample census covering 10 percent of population in rural areas and 100 percent in urban areas (Brass et al., 1968, p. 467). (7) Broad age groups. 1973: (4) Sudan, 1977. (6) WP79. (7) Available at UNSO.

Tanzania 1957: (4) Age distribution smoothed and interpolated for African population. (6) Ominde, 1975, p. 5. 1967: (4) Excluding Zanzibar. (5) UNDY 1971, excluding Zanzibar. (8) Excluding Zanzibar.

Togo 1958-60: (3) Census conducted 11/58-12/60 (UNDY 1970, Table 6). (5) UNDY 1963. 1970: (5) OECD. Myers Index shown is for females; males = 13.8.

Tunisia 1956: (7) Age distribution smoothed and interpolated; ages 0-1 not shown. 1966: (5) UNDY 1971. (6) Low estimate implied by estimate cited in United States Bureau of the Census, 1971; high estimate from UNDY 1970, footnote to Table 6. 1975: (7) and (8) Republique Tunisienne (no date).

Uganda 1959: (4) and (5) OECD. Myers Index shown is for females; males = 20.9. (7) Age distributions smoothed and interpolated; ages 0-1 not shown. 1969: (5) UNDY 1971. (8) Ages 0-1 not shown.

Zaire "Administrative" censuses were reported held in 1970 (WP77) and 1974 (WP79).

Zambia 1963: (7) and (8) Broad age groups. 1969: (5) UNDY 1971. (6) Official estimate cited in WP77.

Zimbabwe (Southern Rhodesia) 1961-62: (3) Census conducted 4/10-5/20/1962 for African population and 11/26/61 for non-Africans (UNDY 1970, Table 6). (4) Age distribution smoothed and interpolated for African population. 1969: (4) UNDY 1972, African population only. (5) UNDY 1971. (6) WP77.

ASIA

Bangladesh 1961: (3) In 1961, Bangladesh was a part of Pakistan. (7) OECD. 1974: (4) and (5) OECD. Myers Index shown is for females; males = 34.6. (6) Based on the results of the Post Enumeration Check (WP77). (9) Cho, 1976.

Burma 1973: (3) 14.9 percent of the territory, with about 2.9 percent of the population, was inaccessible (Cho, 1976). (9) A list of questions is available in Cho, 1976.

China (People's Republic of) 1953: (3) UNSO reports that a census may have been held in June 1964 (UNSO, 1981). (6) UNDY 1976, footnote to Table 6.

Hong Kong 1961: (5) OECD. Myers Index shown is for females; males = 2.0. (6) UNESCAP, 1974. (8) Broad age groups. 1966: (5) OECD. Myers Index shown is for females; males = 1.9. (7) OECD. 1971: (5) UNDY 1973. (6) and (9) Cho, 1976. 1976: (6) WP79.

India 1961: (5) OECD. Myers Index shown is for females; males = 29.2. (6) WP77. 1971: (5) UNDY 1973. (6) Low figure cited in PVSR, 1 April 1980; high figure from WP77. (9) Cho, 1976.

Indonesia 1961: (4) OECD. (7) and (8) Broad age groups. 1971: (5) UNDY 1973. (6) Lower estimate from Cho, 1976; higher from WP75. (9) Cho, 1976.

Iran 1956: (6) Bharier, 1968. (7) Age distributions smoothed. 1966: (5) UNDY 1971. (6) Bharier, 1968. 1976: (6) WP79. (7) and (8) Ages 0-1 not shown.

Iraq 1957: (4) UNDY 1962. 1965: (5) UNDY 1971.

Jordan 1961: (6) Official figure is 4.0; 0.3 added in WP77. 1979: (3) East Bank only (PVSR, 1 Jan. 1981).

Kampuchea (Cambodia) 1962: (4) Age distributions may have been smoothed.

Korea, North Last known census of North Korea was held in May 1944.

Korea, South 1955: (5) OECD. Myers Index shown is for females; males = 2.0. 1960: (5) OECD. Myers Index shown is for females; males = 1.7. (6) WP77. 1966: (5) UNDY 1971. (6) WP77. (8) Broad age groups. 1970: (5) UNDY 1973. (6) WP77. (9) Cho, 1976. 1975: (5) OECD. Myers Index shown is for females; males = 1.8. (6) WP79.

Kuwait 1961: (7) Broad age groups above age 30.

Lebanon (3) The last census of Lebanon was held in 1932 (ECWA, 1977).

Malaysia 1957: (3) Malaysia was formed in 1963; the 1957 census covered West (Peninsular) Malaysia, while the 1960 census covered Sabah and Sarawak. The 1970 census was the first to cover all three (Cho, 1976). (5) UNDY 1962. 1960: (5) OECD. Myers Index shown is for Sabah females; Sabah males = 18.2; Sarawak females = 19.0; Sarawak males = 17.7. 1970: (4) West Malaysia only. (6) WP79. (9) Cho, 1976.

Nepal 1971: (6) WP79. (8) Ages 0-1 not shown.

Pakistan 1972: (6) From a post-enumeration check (Cho, 1976); there is, however, a controversy over the census results, some researchers indicating an overcount (WP77). (9) Cho, 1976.

Philippines 1960: (5) Shryock and Siegel, 1973, p. 207. 1970: (6) Low figure from Cho, 1976; high figure from WP77. (9) Cho, 1976.

TABLE 2.1 (continued)

Saudi Arabia 1962-63: Results officially repudiated (UNDY 1970, WP75). 1974: Only district totals available, and the count appears high (ECWA, 1977; ECWA, 1978).

Singapore 1957: (5) OECD. Myers Index shown is for females; males = 2.9. (8) Singapore is 100 percent urban. 1970: (5) UNDY 1973. (7) Ages 0-1 not shown. (9) Cho, 1976.

Sri Lanka 1963: (4) and (6) USBC. (5) UNDY 1971. 1971: (4) and (6) USBC. (5) OECD. Myers Index shown is for females; males = 6.4. (9) Cho, 1976.

Syria 1960: (5) OECD. Myers Index shown is for females; males = 9.2. (6) Suggested by comparison of census results with civil registration data (Cairo Demographic Centre, 1970). 1970: (5) UNDY 1973.

Taiwan 1956: (5) UNDY 1962. (6) USBC. (10) Taiwan has a decennial census law. 1966: (4) and (6) USBC. 1970: (4) and (6) USBC. (5) OECD. Myers Index shown is for females; males = 1.4. (7) OECD. 1975: (4) and (6) USBC. (5) OECD. Myers Index shown is for females; males = 1.4. (7) USBC.

Thailand 1960: (4) USBC. (5) OECD. Myers Index shown is for females; males = 2.3. (6) WP77. 1970: (4) USBC. (5) UNDY 1973. (6) Low figure based on a post-enumeration survey (Cho, 1976); high figure from WP77. (9) Cho, 1976.

Turkey 1955: (5) OECD. Myers Index shown is for females; males = 13.3. 1960: (4) Shryock and Siegel, 1973, p. 222. (5) OECD. Myers Index shown is for females; males = 14.2. 1965: (5) UNDY 1971. 1970: (5) UNDY 1973. 1975: (6) WP79. (7) Ages 0-1 not shown.

Vietnam 1960: (3) Conducted in northern part of the country only. (7) Broad age groups. 1974: (3) Conducted in northern part of the country only.

Yemen (Aden) 1973: (7) and (8) Ages 0-1 not shown.

LATIN AMERICA

Argentina 1960: (6) Low figure from WP75; high figure from UNDY 1969, footnote to Table 9. 1970: (7) Ages 0-1 not shown.

Bolivia 1950: (6) Low figure from UNDY 1971, footnote to Table 4; high figure implied by adjusted mid-year population in PVSR, April 1975. 1976: (4) UNDY 1977. (6) WP79. (Low estimate is adjustment made by United States Bureau of the Census; high estimate is based on preliminary results of the post-enumeration survey.)

Brazil 1960: (5) OECD. Myers Index shown is for females; males = 8.3. 1970: (6) WP79.

Chile 1960: (6) Low figure from USBC; high figure from UNDY 1965, footnote to Table 2. 1970: (6) USBC. (7) and (8) Ages 0-1 not shown.

Colombia 1964: (6) WP75. 1973: (4) and (5) OECD. Myers Index shown is for females; males = 7.0. (6) WP79.

Costa Rica 1963 and 1973: (6) USBC.

Cuba 1970: (4) UNDY 1972.

Dominican Republic 1960 and 1970: (6) Implied by estimates cited in WP77.

Ecuador 1974: (6) WP79.

El Salvador 1961 and 1971: (6) Implied by comparison with official mid-year estimate in WP77.

Guatemala 1964: (6) Implied by estimate cited in WP77. 1973: (6) USBC.

Haiti 1950: (6) Low figure from WP75; high figure from UNDY 1970, footnote to Table 2. 1971: (6) WP79.

Honduras 1961 and 1974: (6) USBC.

Jamaica 1960: (4) and (6) USBC. (5) UNDY 1962. 1970: (4) USBC. (6) WP79. (7) First two age groups are less than 2 and 2-4, according to UNDY 1977.

Mexico 1960: (6) WP77. 1970: (6) WP79.

Nicaragua 1963 and 1971: (7) and (8) Ages 0-1 not shown. 1971: (6) WP79.

Panama 1960 and 1970: (6) USBC.

Paraguay 1962: (8) Ages 0-1 not shown. 1972: (6) WP79.

Peru 1972: (6) Low figure from PVSR, 1 April 1980; high figure from WP79.

Puerto Rico 1960: (5) OECD. Myers Index shown is for females; males = 3.3. 1970: (4) UNDY 1972.

Trinidad and Tobago 1960: (4) UNDY 1970. 1970: (6) WP79.

Uruguay 1963 and 1975: (6) Implied by comparison with mid-year estimate cited in WP77. 1975: (4) and (5) OECD. Myers Index shown is for females; males = 1.3.

Venezuela 1961: (6) Low figure from WP75; high figure from UNDY 1970, footnote to Table 6. 1971: (6) WP79.

TABLE 2.2 Number of Countries Conducting a National Census and Percentage of World and Continental Populations Covered by These Censuses, by Ten-Year Periods from 1945 to 1984.

			At Least One Census Held During Decade			Announced Plan for Census to be Held Before End of Decade			No Census During Decade		
Continent	Number of Countries	Total Population (millions)	Number of Countries	Population (millions)	Percentage of Total Population	Number of Countries	Population (millions)	Percentage of Total Population	Number of Countries	Population (millions)	Percentage of Total Population
1945-54[a]											
World	223	2,486	150	2,009	81	--	--	--	73	476	19
Africa	57	217	24	118	54	--	--	--	33	100	46
America, N.	36	218	32	217	99	--	--	--	4	2	1
America, S.	15	110	12	100	91	--	--	--	3	10	9
Asia	46	1,355	23	1,172	87	--	--	--	23	183	13
Europe	41	392	40	392	100	--	--	--	1	0	0
Oceania	27	13	19	11	85	--	--	--	8	2	15
USSR	1	180	--	--	--	--	--	--	1	180	100
1955-64[a]											
World	223	2,982	174	2,142	72	--	--	--	49	840	28
Africa	57	270	36	172	64	--	--	--	21	97	36
America, N.	36	267	34	256	96	--	--	--	2	11	4
America, S.	15	145	13	141	97	--	--	--	2	4	3
Asia	46	1,645	30	920	56	--	--	--	16	725	44
Europe	41	425	38	425	100	--	--	--	3	0	0
Oceania	27	16	22	14	87	--	--	--	5	2	13
USSR	1	214	1	214	100	--	--	--	--	--	--

abundance. In Colombia, the 1973 census was hampered by a teachers' strike on census day--the teachers were the (often unpaid) enumerators. Burma's 1953-54 attempt at a census was disrupted by civil disorders. Saudi Arabia's censuses are considered by the Saudi government to suffer from heavy underenumeration, and the 1962-63 census was officially rejected. Lebanon has not taken a census since 1932 (under the French Mandate), presumably for fear that competing religious factions would cause civil disruption if information about their comparative size were released.

While increased efforts to improve the quality and timing of censuses in LDCs are possible, it may well be that for some countries a truly "modern" census is many years in the future. Problems such as taboos on mentioning the number of one's children, the existence of many different languages and dialects within a country; lack of knowledge of one's age; special difficulties with terrain, transportation, and communications in rural areas; widespread illiteracy; and a general lack of perception as to the value of a census on the part of the general population can be expected to provide serious obstacles in the foreseeable future. Even the typical age structure of an LDC operates to make complete enumeration more difficult. For example, young children are among the most seriously underenumerated groups in LDCs; the fact that they constitute very large proportions of the populations in these countries tends to increase the impact of that underenumeration.

2.6.1 Availability of Census Data on Fertility and Mortality

Table 2.3 indicates whether questions providing specific items of information used in estimating fertility and mortality were included in the censuses that appear in Table 2.1. As shown, a substantial number of countries included in their censuses questions on children ever born and children surviving, and many countries have provided tabulations based on these data to the United Nations for publication in the U.N. Demographic Yearbook. A number of countries have collected information on children born in the past 12 months or other reasonably recent periods up to a few years. The table also indicates which countries have included questions for women on age at marriage or date of first marriage and on deaths in the household during the last 12 months.

Only a handful of countries, most of them in Latin America, have included a question on age of mother at the most recent birth or date of that most recent birth; only Latin American countries have included a question on the age of mother at the date of her first live birth. The small number of countries that have included these questions is not surprising given the difficulty of collecting this type of retrospective information, particularly in a census. In a census, a more satisfactory approach is to ascertain the current age of each woman who has given birth and the date of the most recent birth or the date of the first birth. The question on age of mother at the date of first live birth can be useful in surveys or in small samples of censuses that utilize more carefully trained and supervised interviewers.

2.6.2 Delays in Availability of Census Data

A key issue in the usefulness of census data is the time delay between the date of a census and the availability of provisional and final population counts and an age-sex distribution. Table 2.4 lists by region the censuses in Table 2.1 that were conducted in 1970 and later and shows how many months elapsed after the census date before provisional and final totals were made available in the U.N. publication Population and Vital Statistics Reports (PVSR). It also indicates which (if any) U.N. Demographic Yearbook contains the age distributions and age distributions by urban/rural breakdowns from each census.

Among the countries that have released provisional totals for 1970s censuses, the median delay is 11 months among African and Asian nations and 8 months in Latin America. The median number of months to publication of final population counts was 49 among the 15 of 36 countries in Africa that have reported so far. For the 18 of 25 Asian countries that have released final totals, the median delay was 28.5 months. In Latin America only two of the 23 nations have not yet published final population counts for censuses taken in the early 1970s. For those that have published final counts, the median number of months to publication was 39.

Table 2.4 indicates the number of months (as of January 1981) since a census was taken for those countries that have not yet released final census

1965-74[b]											
World	213	3,604	173	2,645	73	--	--	--	40	959	27
Africa	55	354	35	247	70	--	--	--	20	107	30
America, N.	35	318	34	314	99	--	--	--	1	4	1
America, S.	14	187	12	179	96	--	--	--	2	8	4
Asia	43	2,024	33	1,186	59	--	--	--	10	838	41
Europe	37	459	32	459	100	--	--	--	5	0	0
Oceania	28	19	26	17	89	--	--	--	2	2	11
USSR	1	243	1	243	100	--	--	--	--	--	--
1975-84[b]											
World	213	4,414	113	1,796	41	74	2,555	58	26	66	1
Africa	55	472	32	241	51	19	225	48	4	6	1
America, N.	35	367	19	323	88	15	40	11	1	5	1
America, S.	14	239	6	159	67	6	70	29	2	11	5
Asia	43	2,563	18	590	23	15	1,914	75	10	58	2
Europe	37	484	16	176	36	16	306	63	5	3	1
Oceania	28	23	21	23	100	3	0	0	4	0	0
USSR	1	266	1	266	100	--	--	--	--	--	--

Note: The data in this table take into account only complete enumerations of the population; enumerations on a sample basis are not considered to be "censuses."

[a] The data in this portion of the table are based on countries and territories existing in May 1973 and are therefore not affected by changes in their numbers from period to period. All population figures used are the relevant mid-decade (i.e., 1950 and 1960) estimates shown in the working paper "Total population estimates for world, regions, and countries each year, 1950-1985" (ESA/P/WP.34) prepared by the Population Division, Department of Economic and Social Affairs. Tabulated data taken from United Nations, Secretariat (1974:372).

[b] This portion of the table is based on countries and territories listed by the United Nations in the 1 January 1981 report on dates of national population and/or housing census for the 1970 and 1980 census rounds. Population figures for 1970 were taken from the 1977 U.N. Demographic Yearbook. The estimates of the 1980 population were obtained from the Population Reference Bureau, Inc. World totals are the sum of continental totals.

TABLE 2.3 Presence of Retrospective Questions on Fertility and Mortality on Census Schedules in 1960, 1970, and 1980 Census Rounds: 95 Developing Nations with Estimated Mid-1980 Population of 1 Million or More, by Region.

		Fertility Questions							Mortality Question	
Region, Country or Area	Year of Census	Children Ever Born Alive	Children Still Living	Children Born in Past 12 Months (or other period)	Mother's Age at or Date of First Live Birth	Mother's Age at or Date of Most Recent Birth	Age at or Date of First Marriage	Universe for Fertility and Marriage Questions	Deaths in Household in Past 12 Months	Sources Used to Determine Whether Questions Were Asked[a]
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Africa										
Algeria	1960	--	--	X	--	--	X	Females with a Birth in 1960	u	(1,6)
	1966	--	--	--	--	--	--	--	--	(2,4,6)
	1977	--	--	--	--	--	--	--	u	(2)
Angola	1960	X	--	--	--	--	--	All African Women	--	(1)
	1970	u	u	u	u	u	u	u	u	n.a.
Benin	1979	--	--	--	--	--	--	--	--	(2)
Burundi	1979	u	u	u	u	u	u	u	u	n.a.
Cameroon	1976	--	--	X	--	--	--	Households	X	(2,4)
Central African Republic	1975	X	X	X	--	--	--	All Ever-Married Women	--	(2,4)
Congo	1974	X	X	X	--	--	u	All Women, 12+	X	(2,4)
Egypt	1960	X	X	--	--	--	X	All Married Females	u	(1)
	1966	X	X	--	--	--	--	All Married Females	u	(2)
	1976	X	X	--	--	--	X	Ever-Married Women	u	(2)
Ghana	1960	--	--	--	--	--	--	--	u	(1,7)
	1970	--	--	--	--	--	--	--	--	(2,4)
Guinea	1972	--	--	--	--	--	--	--	--	(2)
Ivory Coast	1975	--	--	--	--	--	--	--	--	(2,4)

Kenya	1962	UN 71	X	X	u	u	--	All Women, 15+	--	(1,7)
	1969	UN 75	UN 75	--	--	X	u	All Women, 12+	--	(2)
	1979	u	u	u	u	u	u	u	u	(2)
Lesotho	1956	--	--	--	--	--	--	--	--	(1)
	1966	--	--	--	--	--	--	--	--	(2,4)
	1976	X	X	X	--	X	--	All Women, 15+	X	(2)
Liberia	1962	--	--	--	--	--	--	--	u	(1)
	1974	X	X	X	--	--	--	All Women 10+	X	(2,4)
Libya	1964	--	--	X	--	--	--	Households as a Whole	u	(1)
	1973	UN 78-H	UN 78-H	--	--	--	X	n.a.	--	(2,4)
Madagascar	1974-75	--	--	--	--	--	--	--	--	(2,4)
Malawi	1966	--	--	--	--	--	--	--	--	(2,4)
	1977	X	X	X	--	--	--	All Women, 10+	X	(2)
Mali	1976	--	--	X	--	--	--	n.a.	X	(2,4)
Mauritania	1976	u	u	u	u	u	u	u	u	n.a.
Morocco	1960	X	UN 78-H	X	--	--	--	All Women	u	(1)
	1971	--	--	--	--	--	--	--	--	(2,4)
Mozambique	1960	X	X	--	--	--	u	All African & Non-African Women, 14+	u	(1)
	1970	u	u	u	u	u	u	u	--	(2,4)
	1980	u	u	u	u	u	u	u	u	n.a.
Namibia	1960	u	u	u	u	u	u	u	u	n.a.
	1970	u	u	u	u	u	u	u	u	n.a.
Niger	1977	--	--	--	--	--	--	--	--	(2)
Nigeria	1963	--	--	--	--	--	--	--	--	(1,2)
	1973	--	--	--	--	--	--	--	--	(2,4)
Rwanda	1978	X	X	X	--	X	--	All Women, 14+	X	(2)
Senegal	1976	--	--	--	--	--	--	--	--	(2,4)
Sierra Leone	1963	--	--	--	--	--	--	--	--	(1,2)
	1974	X	X	X	--	X	--	All Women, 12+	--	(2,4)
Somolia	1975	X	u	X	u	u	u	n.a.	X	(4)
South Africa	1960	--	--	X	--	--	--	All African Women	u	(1)
	1970	--	--	X	--	--	--	All Women	--	(2)
	1980	u	u	u	u	u	u	u	u	n.a.
Sudan	1955-56	u	u	u	u	u	u	u	u	n.a.
	1973	X	u	X	u	--	u	n.a.	u	(4)
Tanzania	1957	X	X	--	--	--	u	All African Women	u	(1)
	1967	UN 75	UN 75	X	--	--	--	n.a.	X	(2,4)
	1978	u	u	u	u	u	u	u	u	n.a.

TABLE 2.3 (continued)

Region, Country or Area	Year of Census	Fertility Questions: Children Ever Born Alive (1)	Children Still Living (2)	Children Born in Past 12 Months (or other period) (3)	Mother's Age at or Date of First Live Birth (4)	Mother's Age at or Date of Most Recent Birth (5)	Age at or Date of First Marriage (6)	Universe for Fertility and Marriage Questions (7)	Mortality Question: Deaths in Household in Past 12 Months (8)	Sources Used to Determine Whether Questions Were Asked[a] (9)
Togo	1958-60	X	X	--	--	--	--	All Women	u	(1,2)
	1970	--	--	--	--	--	--	--	--	(2,4)
Tunisia	1956	X	--	--	--	--	X	All Women	u	(1)
	1966	X	X	--	--	--	--	Ever-Married Women	--	(2)
	1975	X	X	--	--	--	X	Ever-Married Women	--	(2)
Uganda	1959	X	X	X	--	--	--	Adult African Women	u	(1)
	1969	X	X	--	--	X	--	All Women, 13+	--	(2,4)
	1980	u	u	u	u	u	u	u	u	n.a.
Upper Volta	1975	--	--	--	--	--	--	--	--	(4)
Zambia	1963	--	--	--	--	--	--	--	u	(1)
	1969	UN 75	X	--	--	X	--	All Women, 15+	X	(2,4)
	1980	u	u	u	u	u	u	u	u	n.a.
Zimbabwe (Southern Rhodesia)	1961-62	u	u	u	u	u	u	u	u	n.a.
	1969	UN 75	UN 75	--	--	X	--	African Women, 15+	--	(2,10)
Asia										
Afghanistan	1979	--	--	--	--	--	--	--	--	(2)
Bangladesh	1961	X	--	--	--	--	--	Ever-Married Women	u	(1)
	1974	UN 78-H	--	--	--	--	--	Married Women	u	(2,5)
Bhutan	1969	u	u	u	u	u	u	u	u	n.a.
Burma	1973	--	--	--	--	--	--		--	(5)
China (PRC)	1953	u	u	u	u	u	u	u	u	n.a.

Hong Kong	1961	--	UN 65	--	--	--	--	All Ever-Married Women	u	(1)
	1966	UN 75	UN 75	u	u	u	u	All Ever-Married Women	u	(10)
	1971	UN 75	UN 75	--	--	--	X	All Ever-Married Women	--	(5)
	1976	UN 78-H	X	u	u	X	X	All Ever-Married Women	u	(11)
India	1961	--	--	--	--	--	--	--	u	(1)
	1971	--	--	X	--	--	X	All Married Women	u	(4,5)
Indonesia	1961	X	X	--	--	--	--	All Ever-Married Women	u	(1)
	1971	UN 75	UN 75	--	--	--	--	All Ever-Married Women	--	(2,5)
	1980	X	X	--	--	X	X	All Ever-Married Women	u	(11)
Iran	1956	--	--	--	--	--	--	--	u	(1)
	1966	--	--	--	--	--	u	--	u	(2)
	1976	--	--	--	--	--	u	--	u	(2)
Iraq	1957	--	UN 65	--	--	--	X	All Married Women	u	(10)
	1965	X	X	--	--	--	u	All Ever-Married Women	u	(2)
	1977	X	X	--	--	--	--	All Ever-Married Women	u	(3)
Jordan	1961	UN 65	UN 65	--	--	--	--	All Ever-Married Women	u	(1)
	1979	u	u	u	u	u	u	u	u	n.a.
Kampuchea (Cambodia)	1962	UN 71	UN 71	X	--	--	--	All Women, 15+	u	(1)
Korea, S.	1955	--	--	--	--	--	--	--	--	(5)
	1960	UN 65	--	--	--	--	--	All Women	--	(1,5)
	1966	UN 75	--	X	--	--	--	All Ever-Married Women	--	(5)
	1970	UN 75	UN 78-H	--	--	--	--	All Ever-Married Women	--	(2,5)
	1975	X	X	--	--	--	X	All Ever-Married Women	u	(2,11)
	1980	X	X	--	--	--	X	All Ever-Married Women	u	(11)

TABLE 2.3 (continued)

Region, Country or Area	Year of Census	Fertility Questions: Children Ever Born Alive (1)	Children Still Living (2)	Children Born in Past 12 Months (or other period) (3)	Mother's Age at or Date of First Live Birth (4)	Mother's Age at or Date of Most Recent Birth (5)	Age at or Date of First Marriage (6)	Universe for Fertility and Marriage Questions (7)	Mortality Question: Deaths in Household in Past 12 Months (8)	Sources Used to Determine Whether Questions Were Asked[a] (9)
Kuwait	1957	UN 65	X	--	--	--	X	All Ever-Married Women	u	(1)
	1961	u	u	u	u	u	u	u	u	n.a.
	1965	u	u	u	u	u	u	u	u	n.a.
	1970	UN 75	u	u	u	u	u	n.a.	u	(10)
	1975	UN 78-H	UN 78-H	u	u	u	u	n.a.	u	(10)
	1980	u	u	u	u	u	u	u	u	n.a.
Malaysia	1957	UN 65	--	--	--	--	--	All Women, 10+	u	(1)
	1960	UN 65	UN 65	--	--	--	--	All Ever-Married Women	u	(1)
	1970	UN 75	UN 75	--	--	--	--	Ever-Married Women	u	(2,5)
	1980	X	X	--	--	--	X	Ever-Married Women, 10+	u	(11)
Mongolia	1956	u	u	u	u	u	u	u	u	n.a.
	1969	u	u	u	u	u	u	u	u	n.a.
	1979	u	u	u	u	u	u	u	u	n.a.
Nepal	1961	UN 78-H	--	--	--	--	--	Ever-Married Women, 15+	u	(1)
	1971	UN 75	UN 75	X	--	--	--	Ever-Married Women	u	(2,11)
Pakistan	1961	X	--	--	--	--	X	All Ever-Married Women	u	(1)
	1972	X	X	--	--	X	X	All Ever-Married Women	--	(2,5)

Philippines	1960	X	X	--	--	--	--	All Ever-Married Women	u	(1)
	1970	UN 75	UN 75	--	--	--	X	All Ever-Married Women	--	(2,5)
	1975	X	X	--	--	--	--	Ever-Married Women	u	(11)
	1980	X	X	X	--	--	X	Ever-Married Women	u	(11)
Saudi Arabia	1962-63	u	u	u	u	u	u	u	u	n.a.
	1974	--	--	--	--	--	--	--	--	(3)
Singapore	1957	--	--	--	--	--	--	--	u	(1)
	1970	UN 75	UN 75	--	--	--	X	Ever-Married Women	--	(2,5)
	1980	X	--	--	--	--	X	Ever-Married Women	u	(11)
Sri Lanka	1963	--	--	--	--	--	--	--	u	(1)
	1971	UN 78-H	UN 78-H	--	--	X	X	All Ever-Married Women	--	(2,5)
Syria	1960	X	UN 78-H	--	--	--	X	All Currently-Married Women	u	(1,3)
	1970	UN 75	UN 75	--	--	--	u	n.a.	u	(2,3)
Taiwan	1956	u	u	u	u	u	u	u	u	n.a.
	1966	X	u	u	u	u	u	All Ever-Married Women	u	(8)
	1970	--	--	--	--	--	--	--	--	(5)
	1975	u	u	u	u	u	u	u	u	n.a.
Thailand	1960	UN 65	--	--	--	--	--	Ever-Married Women, 13+	u	(1)
	1970	UN 75	X	--	--	--	--	Persons, 11+	--	(2,5)
	1980	X	X	--	--	--	X	Ever-Married Women	u	(11)
Turkey	1955	u	u	u	u	u	u	u	u	n.a.
	1960	--	--	--	--	--	--	--	u	(1)
	1965	u	u	u	u	u	u	u	u	n.a.
	1970	UN 75	UN 78-H	--	--	--	u	All Ever-Married Women	u	(2)
	1975	UN 78-H	--	--	--	--	u	Ever-Married Women, 12+	u	(2,10)
	1980	u	u	u	u	u	u	u	u	n.a.
Vietnam	1960	u	u	u	u	u	u	u	u	n.a.
	1974	u	u	u	u	u	u	u	u	n.a.
	1979	u	u	u	u	u	u	u	u	n.a.
Yemen (Aden)	1973	--	--	--	--	--	--	--	u	(3)
Yemen (San'a)	1975	--	--	--	--	--	X	Total Population	u	(3)

TABLE 2.3 (continued)

		Fertility Questions							Mortality Question	
Region, Country or Area	Year of Census	Children Ever Born Alive (1)	Children Still Living (2)	Children Born in Past 12 Months (or other period) (3)	Mother's Age at or Date of First Live Birth (4)	Mother's Age at or Date of Most Recent Birth (5)	Age at or Date of First Marriage (6)	Universe for Fertility and Marriage Questions (7)	Deaths in Household in Past 12 Months (8)	Sources Used to Determine Whether Questions Were Asked[a] (9)
Latin America										
Argentina	1960	UN 69	--	--	--	--	X	All-Ever Married Women	u	(1)
	1970	UN 75	X	--	--	--	--	All Women, 12+	--	(2)
	1980	u	u	u	u	u	u	u	u	n.a.
Bolivia	1950	u	u	u	u	u	u	u	u	n.a.
	1976	UN 78-H	X	--	--	X	u	n.a.	u	(2)
Brazil	1960	UN 78-H	X	--	--	--	X	All Women, 10+	u	(1)
	1970	UN 75	UN 75	X	--	--	--	All Women, 15+	--	(2)
	1980	u	u	u	u	u	u	u	u	n.a.
Chile	1960	UN 69	--	--	--	--	--	All Women, 12+	u	(1)
	1970	UN 75	X	--	--	--	--	All Women, 15+	--	(2)
Colombia	1964	--	--	--	--	--	--	--	u	(1)
	1973	UN 75	UN 75	--	--	X	--	All Women, 15+	--	(2)
Costa Rica	1963	--	--	--	--	--	--	--	u	(1)
	1973	UN 75	UN 75	--	--	--	--	All Women, 15+	--	(2)
Cuba	1953	UN 59	u	u	u	u	u	n.a.	u	(10)
	1970	u	UN 75	u	u	u	u	n.a.	u	(10)
Dominican Rep.	1960	--	--	--	--	--	--	--	u	(1)
	1970	UN 75	UN 75	X	--	--	--	All Women, 15+	--	(2,9)
Ecuador	1962	--	--	--	--	--	--	--	u	(1)
	1974	UN 75	UN 78-H	--	--	X	--	All Women, 15+	--	(2)
El Salvador	1961	--	--	--	--	--	--	--	u	(1)
	1971	UN 75	UN 75	X	--	--	--	All Women, 14+	--	(2,9)
Guatemala	1964	X	--	--	X	--	--	All Women Who Have Borne Children	u	(1)
	1973	UN 75	UN 78-H	--	--	X	--	All Women, 15+	--	(2)

Haiti	1960	u	u	u	u	u	u	u	u	n.a.
	1971	--	--	X	--	--	--	All Women, 15-49	X	(2,9)
Honduras	1961	--	--	--	--	--	--	--	u	(1)
	1974	UN 78-H	X	--	--	X	--	All Women, 15+	--	(2)
Jamaica	1960	UN 69	UN 69	X	X	--	--	All Women, 14+	u	(1)
	1970	X	--	X	X	X	X	All Women, 14+	--	(2,9)
Mexico	1960	UN 69	--	--	--	--	--	All Women	u	(1)
	1970	UN 75	--	--	--	--	--	All Women, 12+	--	(2)
	1980	u	u	u	u	u	u	u	u	n.a.
Nicaragua	1963	UN 71	--	--	--	--	--	All Women Who Have Borne Children	u	(1)
	1971	UN 78-H	UN 78-H	X	--	--	--	All Women, 15+	--	(2,9)
Panama	1960	--	--	--	--	--	--	--	u	(1)
	1970	X	--	X	--	--	--	All Women, 15+	--	(8,9)
	1980	u	u	u	u	u	u	u	u	n.a.
Paraguay	1962	UN 69	--	--	X	--	--	All Women, 12+	u	(1)
	1972	UN 75	UN 78-H	--	--	X	--	All Women, 15+	--	(2,9)
Peru	1961	UN 65	--	--	X	--	--	All Women	u	(1)
	1972	UN 75	UN 78-H	X	X	--	--	All Women, 12+	X	(2,9)
Puerto Rico	1960	UN 69	--	--	--	--	X	Ever-Married Women, 14+	--	(1)
	1970	UN 75	--	--	--	--	X	All Women, 14+	--	(9)
	1980	X	--	--	--	--	X	All Women, 15+	--	see notes
Trinidad and Tobago	1960	UN 78-H	--	X	X	--	X	All Women	u	(1)
	1970	X	--	X	X	X	X	All Women, 14+	--	(9)
	1980	u	u	u	u	u	u	u	u	n.a.
Uruguay	1963	--	--	--	--	--	--	--	u	(1)
	1975	UN 78-H	UN 78-H	X	--	--	--	All Women, 15+	--	(2)
Venezuela	1961	UN 69	--	--	X	--	--	All Women, 12+	u	(1)
	1971	X	--	--	--	--	--	All Women, 15+	--	(2)

Notes:

UN(year) = Question asked and data available in indicated issue of U.N. Demographic Yearbook.

X = Question asked.

-- = Question not asked.

u = Status of question unknown (not determined).

n.a. = Not Available.

TABLE 2.3 (continued)

Provided below is additional information for some countries. The census questions are referred to by column number. In some cases the notes indicate a published source for the data obtained from a given question.

[a]Column 9 numbered sources:

1. United Nations, 1974 (Handbook of Census Methods): Tables IV.1, IV.7, and IV.8.
2. United Nations Statistical Office files.
3. United Nations Economic Commission for Western Asia, 1978.
4. United Nations Economic Commission for Africa, 1977.
5. Cho, 1976.
6. Cairo Demographic Centre, 1970.
7. Caldwell and Okonjo, 1968.
8. U.S. Bureau of the Census 1977-78, pertinent country issue.
9. Organization of American States, 1977.
10. U.N. Demographic Yearbook.
11. United Nations Economic and Social Commission for Asia and the Pacific, 1980.

AFRICA

Algeria 1960: (3) By sex. (6) Year of present or last marriage asked.

Angola 1960: (1) By sex. (3) Children born alive in the last 12 months and last 5 years asked of non-African population.

Congo 1974: (8) Questions on paternal and maternal orphanhood also asked.

Egypt 1960: (1) Duration of marriage asked for total married life. 1966: (1) Children born dead also asked. (7) For present and previous marriages. 1976: (1) and (2) Available from CAPMAS; also by urban/rural.

Ghana 1960: Retrospective fertility questions were included in the Post-Enumeration Survey (Caldwell and Okonjo 1968, p. 124). 1970: the 1971 Supplementary Inquiry included retrospective fertility questions (USBC; UNECA, 1977).

Kenya 1962: (1) Data exclude women in Northern Province and 437,043 women with an unknown number of children ever born (UNDY 1965, footnote to Table 9). (2) Data shown in UNDY 1971 for non-African population only. 1969: (8) Questions on paternal and maternal orphanhood asked.

Lesotho 1976: (1) and (2) By sex. (5) Also asked if child is still living. (8) Also asked age at death.

Liberia 1974: (7) Census form also states that questions on children ever born and children surviving are to be asked of "all women over age 14 regardless of marital status."

Libya 1973: (6) Total duration of marriage.

Malawi 1977: (8) Questions on paternal and maternal orphanhood also asked.

Mozambique 1960: (1) By sex.

Rwanda 1978: (5) Also asked about deaths to infants born in the last 12 months.

Sierra Leone 1974: (8) Questions on paternal and maternal orphanhood asked.

South Africa 1960: (1) Children ever born was asked for all ever-married non-African women and published in UNDY 1965, Table 9. (3) Also asked if child died before 12 months of age.

Zimbabwe (Southern Rhodesia) 1969: (5) Also asked if child is still living.

Sudan 1973: (3) Children born in the past 12 months who died also asked.

Tanzania 1957: (3) Births since January 1, 1956 asked of ever-married non-African population. 1967: (1) and (2) Also shown by urban/rural. (8) Asked sex and age at death.

Tunisia 1966: (1) and (2) Republique Tunisienne (1973). 1975: (1) and (2) Available in unpublished tables at CPD.

Uganda 1959: (1) Children who died before or after age 1 also asked. 1969: (8) Questions on paternal and maternal orphanhood asked.

Zambia 1969: (8) By sex for deaths to persons under age 5 and 5 and over.

ASIA

Bangladesh 1961: Bangladesh was a part of Pakistan in 1961. (6) Duration of marriage asked for total married life. 1974: Detailed fertility questions asked on a postcensal survey; see Bangladesh, 1977. (6) Duration of current marriage asked.

Kampuchea (Cambodia) 1959: (1) Data collected by sex.

Hong Kong 1976: The 1976 By-census has associate status with the World Fertility Survey. (2) and (5) Asked of ever-married women aged 15-49.

Indonesia 1971: (1) and (2) Also by urban/rural.

Iraq 1957: Data in UNDY 1965 are for December 1957 census, but the U.N. Handbook (U.N., 1974) indicates questions were not asked. (6) Date or duration of present/last marriage asked of all women.

Korea, S. 1966 and 1970: (1) Also by urban/rural. 1975: (1) USBC.

Kuwait 1957: (1) By broad age groups. (2) By sex. (6) Age and duration for total married life for all ever-married persons. 1970: (1) Kuwaiti population only.

TABLE 2.3 (continued)

Malaysia 1970: (1) and (2) Also by urban/rural. (2) For West Malaysia only total for ever-married women aged 10 and over shown. (6) Number of times married and years married asked for present and prior marriages.

Nepal 1971: (3) Nepal, 1975.

Pakistan 1961: (6) Duration of total married life asked. 1972: Questions shown here were asked in a survey taken as a part of the overall census program. (1) and (2) By sex.

Philippines 1970: (1) and (2) Also by urban/rural.

Saudi Arabia 1962-63: Census officially rejected.

Singapore 1970: (1) and (2) Data by broad age groups. (6) Age at and date of first marriage asked.

Sri Lanka 1971: (5) Within past 5 years. (6) Age and duration asked for present and prior marriages.

Syria 1960: (1) Present or last marriage only. (2) Asked for present marriage (ECWA, 1978) but not listed in U.N. Handbook (U.N., 1974). (6) Duration of present marriage also asked. 1970: (1) and (2) Syrian population only; also by urban/rural. (7) CEB asked of married women; children surviving for ever-married women.

Taiwan 1966: (1) USBC.

Thailand 1970: (1) Also by urban/rural.

LATIN AMERICA

Argentina 1960: (6) Year of most recent marriage asked.

Brazil 1960: (6) Year of most recent marriage asked. 1970: (1) and (2) Also by urban/rural.

Chile 1970: (1) Also by urban/rural; data by broad age groups.

Colombia 1973: (1) Also by urban/rural.

Cuba 1970: (2) Also by urban/rural. (5) Asked of women aged 15 to 49.

Dominican Republic 1970: (1) and (2) Also by urban/rural. (3) Births in 1969 asked of women aged 15 to 49. (6) Duration asked for persons aged 15 and over and living in "union libre" (consensual unions).

Ecuador 1974: (1) Also by urban/rural.

El Salvador 1971: (1) and (2) Also by urban/rural. (3) Number of children born in 1970 asked of women aged 14 to 49; also asked how many of those born in 1970 died in that year.

Guatemala 1973: (1) Also by urban/rural. (5) Whether last child living also asked.

Haiti 1971: (3) By sex. (8) Also asked age and sex.

Honduras 1974: (5) Whether last child living also asked.

Jamaica 1960: (1), (2), (3) By sex. 1970: (1) USBC (3) Data on live births/still births collected separately. (6) Duration of current union for women under age 45 and duration of union at age 45 for women aged 45 and over.

Nicaragua 1971: (3) Children born in 1970 asked of women 15-49; also asked how many of those born in 1970 died in that year. (8) Question on maternal orphanhood asked.

Panama 1970: (1) USBC. (3) Asked of women aged 15 to 50.

Paraguay 1972: (1) Also by urban/rural. (5) Whether last child living also asked. (8) Question on maternal orphanhood asked.

Peru 1972: (1) Also shown by urban/rural. (8) Question on maternal orphanhood also asked.

Puerto Rico 1970: (1) Also shown by urban/rural. 1980: (9) Francese, 1979.

Trinidad and Tobago 1960: (6) Duration of present or last marriage asked (at age 45 if older than 45) including common law unions. 1970: (3) Data on still births also collected. (6) Duration of current union for women under age 45 and duration of union at age 45 for women aged 45 and over.

Jordan	11/79	4	--	13	--	--
Korea, South	10/70	--	11		1973	1973
	10/75	5	50		1977	1977
	10/80	--	--	2	--	--
Kuwait	4/70	--	20		1972	--
	4/75	11	26		1975[b]	--
	4/80	--	--	8	--	--
Malaysia	8/70	16	43		1973	1973
	6/80	--	--	6	--	--
Mongolia	1/79	17	--	23	--	--
Nepal	6/71	15	30		1973	1973
Pakistan	9/72	12	42		--	--
Philippines	5/70	--	16		1973	1973
	5/75	13	--	67	--	--
	5/80	--	--	7	--	--
Saudi Arabia	9/74	18	--	75	--	--
Singapore	6/70	--	9		1970	--
	6/80	--	--	6	--	--
Sri Lanka	10/71	2	14		1978-H	1978-H
Syria	9/70	6	42		1973	1973
Thailand	4/70	11	44		1973	1973
	4/80	--	--	8	--	--
Turkey	10/70	11	--	122	1972[b]	--
	10/75	14	32		1976[b]	--
	10/80	--	--	2	--	--
Vietnam, North	4/74	29	--	80	--	--
	11/79	--	10		--	--
Yemen (Aden)	5/73	13	46		1974	1978-H
Yemen (San'a)	1/75	5	--	71	--	--

totals. The median number of months in this last category is 46 among African nations and 18 among Asian nations. For many of these countries, especially in Africa, the indicated census is the first. Not surprisingly, the first census often requires more time between field work and the publication of results, especially time for data processing. However, even before the results of these first censuses are published, the data are made available to and used by governments in their planning. These first censuses also provide important baseline information for the long-term development of statistical systems. Many countries in Africa, and a few in Asia and Latin America, have not yet provided age distributions for publication in the U.N. Demographic Yearbooks for censuses conducted in the 1970s.

2.7 MEASURING ERROR IN CENSUS DATA

Although a census is an effort to enumerate every eligible person within the defined area, it is known that this is an ideal that is not attained in actual practice. Moreover, it is futile to expect that each item of information will be reported correctly. In order to use census data, some measure of its accuracy is needed. To meet this need, a number of methods have been developed for assessing the quality and completeness of a census. In the following discussion, several general error problems in censuses are discussed first, and then attention is focused on completeness of enumeration and the accuracy of the age data because of the importance of these items in estimating fertility and mortality.

Errors arise most fundamentally through the failure of respondents to provide full and accurate information. This is more likely to happen when the information relates to another person in the household, that is, when there is proxy reporting. Errors may arise through a failure to include all the persons living in the specified area, or the respondent may fail to report all of the persons in the household. Entire households may be omitted. Overcounts and double counts may occur. There may be misunderstanding of the concepts being used, with the result that the respondent supplies information for a question that was not asked. Errors may be entered on the questionnaire if the interviewer makes a recording mistake or misunderstands an answer. Errors may also arise during the processing of data. Electronic computers have greatly increased the ability to apply uniform rules for editing and coding, but they are also capable of applying the wrong rule--with great faithfulness to the instructions and disastrous results for the data.

Quality control at all phases of the operation is an essential part of a good census. Equally important is documentation of all steps in the collection and processing of the data. Effective use of census results often requires information on exactly how the operation was carried out and other measures of the quality of the data. The final census reports should include at least summary information on the types and extent of the editing that has been performed.

One way to measure the accuracy or completeness of coverage is to compare census results with other related data, such as that from a post-enumeration survey. Another procedure is to compare the results of one census with those of a previous one, taking into account migration and the number of births and deaths during the period between censuses. In applying this measure one needs some assurance that the degrees of completeness of the two censuses are approximately equal or, if not, that suitable adjustments can be made. The application of these qualifications frequently is not possible in developing nations.

In some instances, reinterviewing a sample of the households included in a census has shed light on the quality of that census, as described earlier. However, reinterviewing in a sample of areas or of households does not necessarily lead to discovery of the persons who were missed in the original enumeration. Social conditions which may have led to underenumeration of specified groups in the population may have the same effect on the second enumeration. For example, highly mobile young men may be no easier to enumerate in a well controlled sample survey than in the census itself. Also, some certain items are equally likely to be underenumerated in both situations, such as a death that occurred during the past 12 months. Similarly, checks against external sources of information--such as school registration, summary information available from income tax returns, and social security records--can be helpful in evaluating the quality of a census, but they are of limited value if they are themselves subject to the same types of errors, for example, missing individuals in certain age groups, or age reporting problems.

TABLE 2.4 Length of Time Between Censuses and International Availability of Provisional and Final Counts and Age-Sex Distribution: 1970 and Later, in Selected Nations in Developing Regions

		International Availability of Data[a]				
			Final Totals		Age Distribution (first UNDY to include data)	
		Provisional Totals	Published in PVSR	Not Yet Published		
Region, Country	Date of Census	(months since census)	(months since census)	(months since census, as of January, 1981)	By Sex	By Sex and Urban/Rural Residence
Africa						
Median	--	11.0	49.0	46.0	--	--
Algeria	2/77	37	--	46	--	--
Angola	12/70	18	--	120	--	--
Benin	3/79	--	--	21	--	--
Burundi	8/79	13	--	16	--	--
Cameroon	4/76	26	44		1978	1978
Central African Republic	12/75	--	--	60	--	--
Congo	2/74	7	--	82	--	--
Egypt	11/76	4	49		--	--

Ghana	3/70	12	36		1971	--
Guinea	12/72	--	--	96	--	--
Ivory Coast	4-5/75	4	40		1977[b]	1977[b]
Kenya	8/79	7	--	16	--	--
Lesotho	4/76	20	--	56	--	--
Liberia	2/74	--	37		1978	--
Libya	7/73	11	62		1975[c]	1975[c]
Madagascar	12/74-6/74	--	--	66	--	--
Malawi	9/77	6	--	39	--	--
Mali	12/76	3	45		--	--
Mauritania	12/76	6	--	48	--	--
Morocco	7/71	5	--	113	1972[c]	1972
Mozambique	12/70	18	78		1977	--
	8/80	--	--	4	--	--
Namibia	5/70	--	61		--	--
Niger	11/77	--	--	37	--	--
Nigeria	11/73	--	--	85	--	--
Rwanda	8/78	16	--	28	--	--
Senegal	4/76	5	53		1977	--
Sierra Leone	12/74	6	39		1977	--
Somalia	2/75	--	--	70	--	--
South Africa	5/70	19	82		1972[c]	1976
	5/80	--	--	7	--	--
Sudan	4/73	17	62		--	--
Tanzania	8/78	22	--	28	--	--
Togo	3-4/70	5	17		1977	--
Tunisia	5/75	22	64		--	--
Uganda	1/80	--	--	11	--	--
Upper Volta	12/75	3	--	60	--	--
Zambia	8-9/80	--	--	3	--	--

TABLE 2.4 (continued)

		International Availability of Data[a]				
			Final Totals		Age Distribution (first UNDY to include data)	
		Provisional Totals	Published in PVSR	Not Yet Published		
Region, Country	Date of Census	(months since census)	(months since census)	(months since census, as of January, 1981)	By Sex	By Sex and Urban/Rural Residence
Asia						
Median	--	11.0	28.5	18.0	--	--
Afghanistan	6/79	6	--	18	--	--
Bangladesh	3/74	9	27		1978-H	1978-H
Burma	4/73	8	74		--	--
Hong Kong	3/71	6	18		1973	--
	5-8/76	--	--	52	1978-H	--
India	4/71	2	23		1972	1973
Indonesia	9/71	12	54		1973[c]	1973[c]
	10/80	--	--	2	--	--
Iran	11/76	4	--	49	1978	1978
Iraq	10/77	5	--	38	--	--

TABLE 2.4 (continued)

Region, Country	Date of Census	International Availability of Data[a]				
		Provisional Totals	Final Totals		Age Distribution (first UNDY to include data)	
		(months since census)	Published in PVSR (months since census)	Not Yet Published (months since census, as of January, 1981)	By Sex	By Sex and Urban/Rural Residence
Latin America						
Median	--	8.0	39.0	7.0	--	--
Argentina	9/70	6	--	123	1973	--
	10/80	--	--	2	--	--
Bolivia	9/76	3	18		1977	--
Brazil	9/70	6	30		1972	1972
	9/80	--	--	3	--	--
Chile	4/70	8	83		1972[b]	1972[b]
Colombia	10/73	14	50		1976[b]	--
Costa Rica	5/73	10	22		1974	1974
Cuba	9/70	3	54		1972[c]	1972[c]
Dominican Republic	1/70	8	26		1972	1974

Ecuador	6/74	3	33		1975[b]	1975[b]
El Salvador	6/71	9	18		1972	1972
Guatemala	3/73	15	48		1974[c]	1974[c]
Haiti	8/71	7	43		1978-H	1978-H
Honduras	3/74	9	39		1977	1977
Jamaica	4/70	11	83		1973	--
Mexico	1/70	5	14		1972	--
	6/80	3	--	6	--	--
Nicaragua	4/71	14	44		1974	1974
Panama	5/70	1	22		1973	--
	5/80	4	--	7	--	--
Paraguay	7/72	23	41		1975	1975
Peru	6/72	6	21		1978-H	1978-H
Puerto Rico	4/70	8	23		1972	1972
	4/80	--	--	8	--	--
Trinidad and	4/70	17	77		1978-H	--
Tobago	5/80	--	--	7	--	--
Uruguay	5/75	1	--	67	1978[b]	1978[b]
Venezuela	11/71	13	67		1978-H	--

---

[a] International availability was measured as the appearance of the data in one of two United Nations publications: Population and Vital Statistics Report (PVSR), published quarterly; and the United Nations Demographic Yearbook (UNDY), published annually. 1978-H indicates the Historical Supplement to UNDY 1978.

[b] Provisional; no final figures yet published.

[c] Provisional, but final figures published in a subsequent volume.

2.7.1 Estimating Completeness of Coverage

Table 2.5 (panel A) summarizes information on estimated underenumeration in selected censuses in the 1960, 1970, and 1980 rounds. Estimates are available for 15 censuses (12 countries) in Africa, 29 censuses (17 countries) in Asia, and 33 censuses (21 countries) in Latin America. The median estimated levels of underenumeration are about 3 percent in Asia, 4 percent in Latin America, and 5 percent in Africa, but the range is considerable--from 0.1 to 12.5 percent. Most of the estimates shown were collected from national governments or prepared by the International Statistical Programs Center at the U.S. Bureau of the Census, and the methods used are subject to several limitations. For example, the population enumerated in one census is compared with the population expected on the basis of projections from an earlier census. Ideally, such projections should be based on demographic models or on analysis of the relevant and available demographic experience.

Although some of the estimates shown in Table 2.5 are very low and probably unreliable, they provide useful and probably minimum average indicators of the levels of underenumeration. Where such computations are available for two or three censuses, they tend to indicate different patterns over time. In some countries (e.g., Iran and Costa Rica) available data suggest that completeness of coverage has increased in recent censuses. In other countries (e.g., Sierra Leone, South Korea, and the Dominican Republic), later censuses have higher levels of reported underenumeration, which may be explained in part by improved methods for measuring underenumeration in some of the more recent censuses.

2.7.2. Imputation

A question related to coverage completeness is what procedures should be adopted for handling partial or missing information? A census interview or proxy reporting by neighbors may produce little information beyond the number of people in the household, or a household may not be interviewed despite information that the household exists, or information on one or a few items may be missing. In data collection processes as large as censuses, it is necessary to have relatively uniform procedures for handling such cases. Repeat

TABLE 2.5 Measures of Accuracy and Completeness of Censuses in the 1960, 1970, and 1980 Rounds: Selected Developing Countries by Region

Measure	Africa	Asia	Latin America
Total Number of Countries	40	32	23
Total Number of Censuses	69	78	49
A. Estimated Percentage Underenumeration			
Number of censuses for which data are available (percentage of total censuses)	15 (22%)	29 (37%)	33 (67%)
	(number)	(number)	(number)
Percent: 0-1.9	1	11	5
2.0-3.9	5	5	10
4.0-5.9	5	9	10
6.0+	4	4	8
	(percent)	(percent)	(percent)
Median	4.8	2.9	4.0
Mean	5.1	3.1	4.5
Range	1.6-11.0	0.1-7.5	0.4-12.5
B. U.N. Index of Age-Sex Accuracy			
Number of censuses for which data are available (percentage of total censuses)	39 (57%)	52 (67%)	43 (88%)
	(number)	(number)	(number)
Index Value: 0-19	2	3	13
20-39	7	23	28
40-59	19	16	2
60+	11	10	0
	(index)	(index)	(index)
Median	49	40	25
Mean	53	47	25
Range	11-109	18-123	10-52
C. Myers Index of Age Heaping			
Number of censuses for which data are available (percentage of total censuses)	20 (29%)	32 (41%)	37 (76%)
	(number)	(number)	(number)
Index Value: 0-0.9	0	1	1
1.0-9.9	6	16	24
10.0-19.9	8	6	10
20.0-29.9	4	4	2
30+	2	5	0
	(index)	(index)	(index)
Median	15.4	8.4	8.4
Mean	18.8	12.3	8.4
Range	6.4-66.4	0.8-34.7	0.9-22.2

Source: Table 2.1

visits to the field are not feasible in all cases, and even if possible, multiple return visits would not produce complete information. One common procedure is to impute missing information on the basis of past or current information (United Nations, 1980).

In earlier censuses a standard technique during the editing of census data was to treat inconsistencies or missing information (blanks) as "don't know" responses, with published distributions showing the number of "don't know" cases. However, data users wanted to present distributions or otherwise analyze the findings, and they disregarded "don't know" cases. This practice implicitly assumed the same distributions among the "don't know" responses as among the known cases, for example on age or number of living children, an assumption often not valid. Also, problems were presented in multivariate analysis by the presence of different numbers of "don't know" cases for selected study variables. Hence the data users directed pressure to census organizations to make more complex allocations of the unknown cases. Three procedures were developed.

The first procedure is the application of a deterministic rule to assign particular values to an inconsistent or unknown case. For example, if the census questionnaire provides information on the occupation and industry of a given individual, the recorded response "never worked" might be changed to the category "worked last year." The second procedure is the cold deck method which involves the insertion of some values that do not depend on material directly observed in traditional ways. The cold deck method is a stochastic process that makes use of more detailed information in the imputation process, e.g., the age distribution of women married to husbands of a particular age (determined from a previous census or survey). The cold deck procedure, sometimes carried out manually with decks of cards containing the appropriate distributions of values to be imputed, is time consuming.

The third procedure is the use of a hot deck in which the information on a recently processed person with similar characteristics, i.e., who falls in the same cell on some selected matrices from the same census or survey, is used to impute the missing information. It is possible to impute all characteristics for a missing person or household with this technique, depending on the rules adopted. The basic idea is to maximize the information available to the statistical office responsible for processing census data, based on the assumption of similarity between persons whose characteristics are known and persons for whom some or many characteristics are unknown. The availability of large-memory computers has enhanced the possibilities for use of the hot deck method. In the 1960 census in the United States, a total of 776,665 persons were imputed or 0.4 percent of the official national count. Subsequent analysis suggested that there may have been an overimputation of 100,000 to 400,000 persons (Taeuber and Hansen, 1964; Shryock and Siegel, 1973).

Imputation rules should avoid the generation of much false information. A decision must be made also whether to impute data on all variables or only on certain items. (For surveys the hot deck method can present more problems because there are fewer cases. Therefore, for surveys the imputation rules cannot be as specific as for censuses.)

A particular problem arises in subsequent analysis of small area data from censuses if much imputation has occurred in some or many of the small areas, such as inner city census districts or sections of shantytowns. However, users can be alerted to potential problems caused by imputation if the tabulations are marked in italics or with a selected symbol when the proportion of imputed cases is above a stated level. An alternative is to suppress data in small area tabulations for those areas that have imputed data above stated proportions.

For variables used in fertility and mortality estimation the imputation rules require consideration of possible circularity for the assumptions underlying indirect estimation techniques. In general the understanding of the effects of imputation, including effects on fertility and mortality estimation, are not well understood and hence require further research.

2.7.3 Assessing the Accuracy of Age Reporting

It is well known that there are certain preferences in age reporting, such as the tendency for people to report ages that end in 0 or 5. In some cultures the preference runs to other digits. Under ordinary circumstances it is reasonable to expect that each terminal digit in an age report is as likely as any other, except when dealing with groups of young ages. Any departure from an equal distribution of terminal digits in the age report is thus a signal of a problem in the quality of the age data.

Interpretation of the computations to measure "age heaping" must take into account the cultural traditions that affect age reporting. Also, one must consider the possibility that changes in digit preference from one census to another may reflect changes in procedures rather than changes in the quality of the data. In one instance there seemed to be a change in digit preference from 0 to 9. The explanation turned out to be very simple. One census had asked for current age, the other had called for year of birth. In the latter case there apparently was a tendency for many people to report a year ending in 0 (e.g., 1930, 1940), with the result that at the time of the census the age at last birthday for most of those people was a number ending in 9.

Another common preference in age reporting is a tendency to favor certain threshold ages, such as the age for entering or leaving school, the age at which legal majority is attained, the minimum age at which an individual can take a job, get married, retire or enjoy certain privileges, such as driving a car. Tendencies for age reports to be biased systematically upward or downward have also been detected. For example, among females in many African countries the bias is systematically upward among older teenagers and women in their early twenties, and in some cases systematically downward for girls aged 10-14. If not adjusted (see Brass et al., 1968; Pison, 1978), these biases cause problems in fertility estimation, because they lead to underestimates of women aged 10-14 and 15-19, and to overestimates of women aged 20-35.

A simple but crude measure of the extent of age misreporting is the United Nations Age-Sex Accuracy Index, which is based on the relative magnitudes of age and sex ratios. In effect, this index is a measure of deviations from expected values based upon a life table population. It does not take account of migration or of critical events in the history of a population that may be very age-selective, for example, high infant and child mortality due to war and famine conditions or heavy losses of military and civilian personnel in wars. (These factors may be less troublesome in many LDCs than they are in developed nations, because many LDCs have not experienced major international migration or large-scale population losses in major wars.) The United Nations has described age-sex data as "accurate," "inaccurate," or "highly inaccurate" depending on whether the U.N. index is under 20, 20-40, or over 40 (Shryock and Siegel, 1973:222). However, some countries with good age reporting have scores in the 20-30 range, e.g., South Korea.

A second summary measure of age misreporting is the Myers Index of Age Heaping, which indicates the extent of concentration on or avoidance of particular terminal digits. It is calculated by determining what proportion of the total population is the group whose reported age ends in a given digit (Shryock and Siegel, 1973, based on Myers, 1940).

Panels B and C in Table 2.5 summarize the U.N. Age-Sex Accuracy Index and the Myers index information presented in Table 2.1. Note that the ranges of these indexes are considerable. The most accurate age reporting in the three regions, as indicated by these indexes, occurs in Latin America, where at least one age misreporting index was calculated for every country. Age reporting has more errors in Asia and more yet in Africa, although the number of countries for which data were not available is substantially larger in these two regions. In general, the two indexes have a high degree of correlation.

There is some evidence that the quality of age data from censuses in LDCs is improving. In the case of Latin America, Kamps reports a median Myers index of 27.3, 17.1, and 12.5 for the 1950, 1960, 1970 rounds respectively (1976:8). However, while the index indicates that reporting improved in the second and third rounds, the decrease in the index from 1960 to 1970 is only half of the 1950-60 decrease, suggesting that improvements from "poor" to "good" data are more likely than changes from "good" to "very good" in the future. A similar impression is conveyed by the U.N. Index for the same three rounds, which has values of 35, 25, and 22, respectively (Kamps, 1976:19).

An analysis of age misreporting for a particular census requires more information than is provided by either or both of these indexes, which are subject to deficiencies. Of the two, the Myers index is subject to fewer biases and is preferable for measuring age misreporting. However, its computation requires that age data be available by single years. The U.N. Index has a considerable advantage in that it requires only tabulations by five-year age groups by sex; such data are often more available than single-year age detail. (For a more detailed discussion of the problem of age misreporting, see Ewbank, 1981.)

Errors in age reporting are not necessarily indicative of errors in reporting other characteristics of the population. Although poor-quality age data probably indicate that the quality of the data on other characteristics is also poor, one cannot assume that high-quality age data imply equally high-quality data on other characteristics.

2.8 CENSUS QUESTIONS RELATED TO FERTILITY

Questions designed specifically to measure current or past fertility have been included in the censuses of many developing countries. As indicated in Table 2.3, there is diversity in the specific questions asked. Children ever born (live births) is the one most frequently included. Some censuses also ask for the number of children still living at the time of the interview and whether they are living at home or elsewhere, or the number of children born during the last year, or during the last five years. In some censuses additional questions ask the age of the mother at first marriage and/or her age at the time of the most recent birth. Such questions normally are asked only of women who have been married, with marriage including consensual unions if this is a common occurrence in the country. The practice of early marriage is reflected in the fact that the target population for such questions is often specified as women 12 years old or over; in at least one country, 10 years is used as the minimum age.

Practices vary. In some cases the questions relating to fertility are included in the full censuses; in others they are included as part of a built-in sample or a sample added to a census. The latter choice may be preferable, for such data are not normally required for small areas within the country; national or regional estimates may satisfy the data needs perfectly well. Appendix B provides further details on the collection of data on children ever born, for use in the estimation of cumulative fertility (and childhood mortality when data on surviving children are also collected).

Table 2.6 summarizes information in Table 2.3 for the period 1965-74, using only the most recent 1970 round census for each country. For many countries the existence or availability of information on particular items is unknown. This is particularly so in Africa. Nevertheless, the available data sources indicate that among the 69 countries with a census in this period, at least 46 definitely included a question on children ever born (19 of 21 in Latin America) and 38 countries included a question on children surviving. These are impressive numbers. (Mortality measures are discussed in the next section, but the item on children surviving is noted here because it is so closely linked to the children-ever-born item in data collection and data analysis.)

As indicated above, one of the advantages of census data for the estimation of fertility and mortality is that even when tabulated only on a sample basis, sufficient numbers of cases are available to allow determination of regional patterns. However, a much smaller number of countries actually tabulate this information than collect it. If each country that collected information on children ever born and children surviving tabulated these data by age of mother (in five-year age groups) in addition to tabulating the age-sex distribution of the population, a considerable amount of fertility and child mortality analysis could be accomplished with relative ease, given current indirect estimation techniques.

Indirect estimation techniques that use data on children ever born and children surviving require tabulations by age of women aged 15 to 34 (Hill et al., 1981), and adjustments are needed if there are obvious errors in the age structure. Also, when fertility and mortality are changing, the estimated levels will refer to a point in time usually a few years prior to the census. Hence, a single census that includes simple questions on children ever born and children surviving can provide the data needed to estimate both relatively recent fertility and child mortality levels; however, there is the concurrent disadvantage that in countries in which fertility and mortality are changing (as is the case in many developing nations) the estimates will refer to a time period perhaps four to six years before the census. This time lag, when combined with the time that elapses between census taking and the availability of tabulations, means that when estimates are calculated and published, they often refer to a time period six, seven, or as much as ten years earlier.

Census data can also be used in applying other techniques for estimating fertility. (Many of these techniques are appropriate with survey data also.) A list of these techniques and the data they require are shown in Table 2.7, part A.

TABLE 2.7 Techniques for Estimating Fertility and Mortality Using Data Collected from Censuses[a]

Technique	Data Required
A. Fertility Estimation	
1. Brass-type methods that compare cumulated fertility rates (F) with reported average parity (P). [Cumulated fertility rates are obtained from data on children born during a recent period, frequently one year. Reported average parity is obtained from data on children ever born (CEB).]	
a. P/F ratio method: age version	Number of CEB, classified by age of mother. Total number of women in each age group. Number of children born during the year preceding the census, classified by age of mother, Or, alternatively, number of registered births in the year of the census, classified by age of mother.[b]
b. P/F ratio method: age version applied to first births only	Number of women who have had at least one child (mothers), classified by five-year groups. Total number of women, classified by five-year age groups. Number of first births occurring during the year preceding the census, classified by five-year age group of mothers. If the census does not include a question on date of most recent birth, these data may be obtained from a vital registration system.[b]

TABLE 2.6 Number of Countries Including Fertility and Mortality Questions in Their Census Schedules and the Availability of Information About Those Questions: 1970 Census Round in Selected Developing Countries, by Region

Part A. Number of Countries Including Fertility and Mortality Questions in Census

Questions	Africa			Asia			Latin America		
	Yes	No	N.D.[a]	Yes	No	N.D.[a]	Yes	No	N.D.[a]
1. Children Ever Born Alive	12	9	3	15	6	3	19	1	1
2. Children Still Living	11	9	4	13	7	4	14	7	0
3. Children Born in Past 12 Months (or other period)	6	15	3	2	18	4	9	11	1
4. Mother's Age at or Date of First Live Birth	0	20	4	0	20	4	3	17	1
5. Mother's Age at or Date of Most Recent Birth	5	16	3	2	18	4	7	13	1
6. Age at or Date of First Marriage	1	17	6	6	10	8	3	17	1
7. Deaths in Household in Past 12 Months	4	16	4	0	11	13	2	18	1

Part B. Availability of Information About Census Questions

	Africa	Asia	Latin America
Countries with a Census	24	24	21
Full information found[b]	17	10	20
Partial information found[c]	5	11	1
No information found[d]	2	3	0
Countries with no Census	15	8	2
Total Number of Countries	40	32	23

Note: Countries with more than one 1970 round census were counted only once.

[a] N.D. = not determined.

[b] A copy of the form or questionnaire was located, making a complete check possible.

[c] Available information suggests that at least one of the questions was included; a full check on the inclusion of all seven questions was not possible from available sources.

[d] Sources available included U.N. Demographic Yearbooks and historical supplements, census files at the U.N. Statistical Office, and sources listed in the notes to Table 2.3.

2.9 CENSUS QUESTIONS RELATED TO MORTALITY

Major emphasis has been placed on securing evidence regarding fertility and child mortality from census data, but other data on mortality in general and on migration (not covered here) may be secured as well. In the absence of complete registration of deaths, some countries have used a census to secure information on the number of deaths during the previous year, or some other time period. (See column 8 of Table 2.3.) Results have generally been unsatisfactory. In some cultures any mention of persons who have died is routinely avoided, and any effort to secure information on deceased persons is likely to meet with resistance. Moreover, the death of an adult may lead to dissolution of the household, with any surviving members of the household being incorporated into one or more other households.

Reasonable estimates of child mortality frequently can be made from data on children ever born and children surviving. (Detailed explanations of the estimation procedures, including examples, are found in Hill et al., 1981). In doing so, care must be taken in the selection of a model life table to make sure that it is applicable to the conditions of the country--for example, when using child mortality estimates to construct infant mortality estimates. For the estimation of adult mortality, the work of Lotka (Lotka and Sharpe, 1911; Lotka, 1939) and model life tables generated by Coale and Demeny (1966) have led to the development of techniques for estimating adult mortality on the basis of age structure and an estimate of the rate of population growth obtained from two successive censuses. (The techniques require estimates of net migration also.) Here also, the selection of appropriate model life tables is critical. This presents a special problem in Africa where the model life tables are quite different from the mortality patterns observed in direct measurement data, usually collected in surveys. In other places, frequently two model life tables must be used, one for children under about age 10 and the other for the population age 10 and over. The techniques of mortality estimation that can be applied using census data, and the data required, are listed in Part B of Table 2.7.

c. P/F ratio method: duration version (based on duration of first marriage, which is defined as the time elapsed since first union [marriage or consensual union], regardless whether subsequent unions have occurred)	Number of CEB, classified by duration of mother's first marriage. Number of ever-married women, classified by five-year marriage-duration groups. Number of children born during the year preceding the census, classified by duration of mother's first marriage, Or, alternatively, registered births in the year of the census, classified by duration of mother's first marriage.[b]
d. The P/F ratio method: duration version applied to first births only	Number of women (mothers) who have had at least one child, classified by duration of first marriage. Number of first births occurring during the year preceding the census, classified by five-year marriage-duration groups of mothers. If the census does not include a question on date of most recent birth, these data may be obtained from a vital registration system.[b] Total number of women, classified by five-year marriage-duration groups.
e. Comparison of cumulated cohort fertility with the average parities reported by the same cohorts at the time of the census	Number of CEB, classified by age of mother. Number of women in each age group from the current census and from one or more earlier censuses. Registered births, classified by age of mother for each of 15 or 20 years prior to the census.[b]
f. Comparison of registered intercensal cohort fertility with the cohort parity increments observed between two censuses	Number of CEB, classified by age of mother for two points in time 5 or 10 years apart. Number of women in each age group at both census dates or enough information to estimate the mid-year female population for each year for which birth registration data are available. Registered births, classified by age of mother for each year between two census dates.

TABLE 2.7 (continued)

Technique	Data Required
2. Intercensal fertility estimation based on cohort parity increments	Number of CEB, classified by age of mother for two points 5 or 10 years apart. Number of women aged 15 to 50, classified by five-year age groups at both points in time.
3. Estimation of the level of natural fertility from parity by duration of first marriage	A value of a(0), the earliest age at which a significant number of marriages take place. Number of women, classified by age and marital status. Number of CEB, classified by duration of mother's first marriage and current marital status.
4. Estimation of fertility by reverse-survival methods	
a. Reverse survival of the population under age 10	Population under age 10, classified by age (in single- or five-year age groups) and by sex. Total population at the time of the census. An estimate of the growth rate. Estimates of the probabilities of surviving from birth to exact x (l_x) for x = 1, 2, ..., 10.
b. Own-children method	Enumerated children (under age 15) whose mother was identified, classified by single years of own age and single years of mother's age. Enumerated children whose mother could not be identified, classified by single years of own age. Total number of women aged 15 to 65, classified by single years of age. Estimates of child mortality for the 15 years preceding the census. Estimates of female adult mortality for the 15 years preceding the census.

B. Mortality Estimation

1. Estimation of childhood mortality from information on CEB and children surviving (in the following four techniques having data classified by sex is useful but not essential)

a.	Using data classified by age	Number of CEB, classified by sex and by mother's age. Number of children surviving (or number of children dead), classified by sex and by mother's age. Total number of women in each age group.
b.	Using data classified by duration of mother's first marriage (time elapsed since first union)	Number of CEB, classified by sex and duration of mother's first marriage. Number of children surviving (or number of children dead), classified by sex and duration of mother's first marriage. Total number of women in each marriage-duration group.
c.	Estimation of intercensal child mortality using hypothetical cohort data derived from two censuses	Number of CEB, classified by five-year age groups of mother (or five-year marriage-duration groups) from two censuses 5 or 10 years apart. Number of children surviving (or dead), classified by five-year age (or marriage-duration) group of mother from the same two censuses. Total number of women in each five-year age (or marriage-duration) group.
d.	Estimation of child mortality when the fertility experience of true cohorts is known	Number of CEB, classified by five-year age (or marriage-duration) group of mother for two censuses 5 or 10 years apart. Number of children surviving (or dead), classified by five-year age (or marriage-duration) group of mother for the more recent census. Total number of women in each five-year age (or marriage-duration) group for both censuses.

TABLE 2.7 (continued)

Technique	Data Required
2. Estimation of conditional adult survivorship functions from information on orphanhood	
a. Brass method and regression method (regression method suitable only for information on maternal orphanhood)	Proportion of persons with surviving mother (or father) in each five-year age group. Number of births in a given year, classified by five-year age group of mother (or father)
b. Using data from two censuses	Proportion of persons with surviving mother (or father) in each five-year age group from two censuses 5 or 10 years apart. Number of registered births classified by five-year age group of mother (or father) for one of the census years, an intermediate year, or both census years.[b]
3. Estimation of conditional adult survivorship functions from information on widowhood	
a. Regression method: age version	Observed singulate mean ages at marriage (SMAM) for men and women. Proportion of ever-married men (or women) whose first wives (or husbands) were alive at the time of the census, classified by five-year age groups.
b. Regression method: duration version	Observed SMAM for males (or females). Proportion of ever-married women (or men) whose first husbands (or wives) were alive at the time of the census, classified by five-year marriage-duration groups (years elapsed since first union).

c. Using data from two censuses	Observed SMAM by sex at two censuses 5 or 10 years apart. Proportions by sex of ever-married population whose first spouse was alive at the time of each census, classified by five-year age (or marriage-duration) groups.
4. Estimation of adult mortality from information on the distribution of deaths by age	
a. Preston-Coale method	Number of deaths occurring in a specific time period, classified by age of decedent in five-year age groups.[b] Population classified by age in five-year age groups for the mid-point of the period to which the deaths refer. An estimate of the growth rate.
b. Brass method	Number of deaths occurring in a specific time period, classified by age (in five-year age groups) and by sex (if available); last age group must be open-ended. Population for the mid-point of the period to which the deaths refer, classified by age and sex to match the classification of deaths.
5. Estimation of adult mortality using age distributions of successive censuses	
a. Intercensal survivorship probabilities	Population at two censuses, classified by sex and age. (If the interval between censuses is not a multiple of five, at least one age distribution should be by single years of age.)
b. Intercensal survivorship probabilities with additional information on age pattern of deaths	Population at two censuses not more than 15 years apart, classified by age and sex. (One age distribution by single years of age is necessary if the intercensal interval is not a multiple of 5.) Number of deaths by age and sex for intercensal period, obtained from a registraion system or estimated using model life tables.[b]

TABLE 2.7 (continued)

Technique	Data Required
C. Estimation of fertility or mortality using stable or quasi-stable models	
1. Assuming stability and using an estimate of the growth rate	The population, classified by five-year age groups and by sex. Total population by sex for at least two points in time. An estimate of net migration during at least the last intercensal period. An estimate of the sex ratio at birth (unless the analysis is to be carried out for males and females separately).[b]
2. Assuming stability and using an estimate of l_2, the probability of surviving from birth to exact age 2	The population, classified by five-year age groups and by sex. An estimate of net migration during the period preceding the census. Number of CEB and number of children surviving, classified by age of mother. An estimate of the sex ratio at birth and the overall sex ratio of the population.
3. Assuming quasi-stability, caused by a long-term trend of mortality decline	Information necessary to obtain stable population estimates (as specified in 1 or, preferably, 2 above). Some basis for estimating the duration and pace of mortality decline, such as evidence of an increasing growth rate, estimates of child mortality from two censuses, or changes in the age composition of deaths.

---

[a] Many of these techniques can also be applied to data collected by surveys. For a more detailed description of these methods including examples, see Hill et al. (1981).

[b] Data that must be obtained from sources other than censuses.

2.10 DESIGN ISSUES AND OPTIONS

Figure 2.3 lists some of the major design issues and options to be considered when planning a census. The issues and options fall into five categories:

I Institutional settings and arrangements
II Cartography
III Enumeration
IV Data Processing
V Dissemination of results

FIGURE 2.3 Major Design Issues and Options in Conducting a Population Census

I. Institutional settings and arrangements

A. Place of census in government
1. Responsibility of national statistical office
2. Responsibility of some other permanent department or agency
3. Independent ad hoc program
4. Other arrangement

B. Permanency of census organisation
1. Significant staff and related infrastructure maintained on a permanent basis
2. Little or no staff or related census infrastructure maintained during intercensal years

C. Integration of census and related programs
1. High degree of integration, including common subject-matter staff, common field organisation, etc.
2. Little or no integration, with separate subject-matter staffs for census and other programs, separate field organisations, etc.
3. Mixed

D. Degree of centralisation of census activity
1. All activities carried out by the central census authorities
2. Responsibility for significant aspects of the census (e.g., field work) decentralised, carried out by provincial or local authorities
3. Mixed

E. Transportation
1. Vehicles obtained from permanent government agency pools or from Army
2. Vehicles hired in private sector
3. Extent to which public transportation can be used

F. Logistics
1. Forms and materials printed centrally and distributed to regions
2. Forms and materials printed in regions
3. Transport of forms, etc. to local areas
   a. Census vehicles
   b. Private vehicles
   c. Public transportation or postal service
4. Transport of completed forms from local areas to central office

II. Cartography

A. Mapping
1. Full mapping
a. Enumerators provided with maps of their individual enumeration area
b. Enumerators not provided with maps of enumeration areas
2. Village lists only
3. Mixed

B. Addresses
1. Full reliance on existing addresses and house numbers
2. All dwellings or structures specially numbered as part of census preparations
3. Mixed

C. Procedures for area identification in the personal and household record
1. Traditional system of hierachical coding of geographic areas down to place (village, town, city, etc.) and/or the minor civil division
2. Extension of the traditional system to include the enumeration area and possibly census tracts
3. Extension of the traditional system to incorporate detailed information on the exact location of the person or household in terms of geographic coordinates, block-face, address, etc. (that is, so-called geo-coding)

D. Extent of quality control required in all aspects of the cartography processes

III. Enumeration

A. Reporting method
1. Census forms completed by enumerator (enumerator or canvasser method)
2. Census forms completed by respondent (self-enumeration or householder method)

B. Counting rules
1. De jure
2. De facto
3. Mixed

C. Use of sampling to collect data on fertility or mortality items
1. Not used
2. Used
a. Some items not included in main census included in supplementary sample survey
b. Some items asked only in a sample of enumeration areas
c. Some items asked only for a sample of households
d. Mixed

D. Type of schedule (see also footnote a, Figure 4.1)
1. Questionnaire (contains full text of all questions to be asked, e.g., "How old is that person?")
2. Form (contains only indication of the topic or items of information sought, e.g., "Age")

Figure 2.3 (continued)

- E. Field staff recruitment
    - 1. Staff temporarily deputed from other government ministries
    - 2. Staff temporarily hired from general public
    - 3. Other arrangements

- F. Method of paying hired field staff

- G. Management of field operations
    - 1. Duration of enumeration
    - 2. Enumerator workload
    - 3. Nature and extent of enumerator training
    - 4. Nature and level of field supervision

- H. Extent of quality control required in all aspects of the enumeration process (including pretesting of forms and questionnaires)

IV. Processing

- A. Method of data capture
    - 1. Entries on schedule converted electronically to computer tape using systems such as (FOSDIC, OMR, OCR, etc.)[a]
        - a. Forms completed at time of enumeration
        - b. Forms completed subsequently
    - 2. Keyboard input to diskette, disk, etc.
    - 3. Punch cards
    - 4. Hand count
    - 5. Mixed

- B. Location of data-capture operations
    - 1. Centralised
    - 2. Multiple locations

- C. Type of editing
    - 1. Manual editing
        - a. in field
        - b. in regional or central office
    - 2. Editing as part of data-capture operations
        - a. in field
        - b. in regional or central office
    - 3. Computer editing
        - a. with imputation
        - b. without imputation

- D. Location of computer
    - 1. Within statistical office
        - a. centralised
        - b. decentralised
    - 2. Within other government agency
        - a. centralised
        - b. decentralised
    - 3. Elsewhere

- E. Source of computer programs
    - 1. Ad hoc programs written specifically for census
    - 2. Existing, locally-developed editing or tabulation programs adopted for census
    - 3. Standard census software packages adopted for census (e.g., COCENTS, CENTS, TAB-68, TPL, UNEDIT, CONCOR, CANEDIT, GTS)[a]
    - 4. Mixed

F. Extent of quality control required in all aspects of data processing

V. Access to and dissemination of results

A. Method of publication for main census reports
1. No census report
2. Typeset
3. Offset copies of typed report
4. Offset copies of computer printouts
5. Computer-driven composition
6. Other or mixed

B. Other forms of access and dissemination
1. No other access or dissemination
2. Microfiche or microfilm copies of unpublished tables
3. Census data base
4. Summary tapes
5. Public-use sample tapes
6. Mixed

---

[a] Explanation of data processing acronyms:

CANEDIT (Canadian editing package)--requires large machine, sophisticated processing capability.

CENTS (Census Tabulation System)--IBM assembler version of COCENTS; requires 24K memory.

COCENTS (COBOL Census Tabulation System)--developed by the U.S. Census Bureau. Requires 64K memory, COBOL compiler, and disk storage.

CONCOR (Consistency and Correction)--performs data editing and imputation. Assembler version developed by CELADE; U.S. Census Bureau has developed COBOL version. Census version (COBOL CONCOR) requires 128K memory, COBOL 74 compiler, and disk storage in the millions of characters.

FOSDIC (Film Optical Sensing Device for Input to Computers)-- transfers data from forms to magnetic tape.

GTS (Generalized Tabulation System)--U.S. Census Bureau package designed for use with UNIVAC machine.

OCR (Optical Character Reader)--reads hand-printed letters, figures, symbols, etc. and converts them to codes.

OMR (Optical Mark Reader)--senses bars, dots, etc. filled in on forms.

TAB-68--cross-tabulation package developed in 1968 by the Swedish Statistical Office. Requires IBM/OS.

TPL (Table Producing Language)--developed by U.S. Bureau of Labor Statistics. Requires IBM/OS with PL1 compiler and 256K memory.

UNEDIT--U.N. editing package designed for use on small computers with small files. Requires 32K memory. COBOL version being developed.

Most of the issues listed in Figure 2.3 have been discussed in greater detail above, but a few of them deserve special emphasis. Perhaps the primary point to be noted is the great range of options that confront planners of a census. Items in the first category, institutional settings and arrangements, seem reasonably straightforward when displayed in a simple list, but they are all factors that can have a huge effect on the ultimate success or failure of the census operation. Likewise, appropriate cartography and carefully defined geographical coding procedures are essential elements of a smoothly conducted census. In addition, the question of quality control is critical in all stages; this includes, for example, pretesting of forms and training and supervision of staff.

The expanding use of electronic computers, noted under Data Processing and Dissemination of Results, is likely to have significant effects on the future use of census data. Census data are fully exploited only rarely; tabulation and publication of results, including those related to fertility and mortality, are usually limited to only a fraction of what would be possible. The widespread application of computers in tabulating census results has opened up additional possibilities for extracting useful information from the census questionnaires, including the study of differentials by geographic region and socioeconomic groups. It is expected also that prospective improvements in programming will increase the timeliness of tabulations and publication of data as well as make possible more effective use of the information collected. Another significant development is that of making data tapes with individual identifiers deleted, available to analysts and other users outside the census offices. This practice increases the possibilities for additional skilled analysis of the data.

2.11 SUMMARY

The ideas and comments presented in this chapter suggest the following five summary points:

1. Census data are important and valuable for the estimation of levels and trends of fertility and mortality. They are useful for the direct computation of some basic measures, such as crude birth and death rates and age-specific rates, although these estimates normally

can be made only in conjunction with data from other sources--either surveys or CR/VS systems. (In theory, it is possible to calculate crude birth and death rates from census data only, that is, to obtain the numerator, as well as the denominator, from census data. Unfortunately, past experience suggests that this procedure so often yields such erroneous results that it is of limited practical value.) Censuses also provide the data for the denominator values needed to calculate vital rates. Where CR/VS systems are well developed, the combination of CR/VS and census data makes possible the estimation of birth and death rates for sub-regions and districts.

2. In developing nations, censuses can be particularly useful for the estimation of fertility and mortality via indirect estimation techniques. The necessary questions are not elaborate, but this is not to suggest that they are automatically easy to administer, transcribe, code, tabulate, and analyze. Collection and tabulation can be simplified by using built-in samples or samples added to censuses, generally samples of 10 percent or 5 percent and in some cases even 1 percent. Failures in the collection of data designed for indirect estimation techniques have occurred in some places, but in other places the techniques have proved to be powerful estimation tools.

3. To provide for the best use of census data for fertility and mortality estimation, as well as for estimating other parameters, attention must be directed to minimizing, detecting, and measuring errors in census data. Age misreporting is a primary problem.

4. Because censuses do not occur frequently, great care can be devoted to their design and execution. However, the infrequent nature of censuses also means that the baseline data they provide for estimating crude rates are often out of date. This is particularly true for geographic subdivisions of countries, because levels of internal migration may be unknown even when reasonably reliable estimates of vital rates can be constructed at the national level. For the same reason, census data are not the most appropriate basis for estimating trends in vital rates, except in a broad context and in the absence of other data collection mechanisms. However, censuses are useful for obtaining data to construct extended time series. In countries where quinquennial censuses are taken (e.g., Korea and Turkey), censuses can provide better information on recent trends.

5. Censuses will continue to be taken, with fertility and mortality estimation being only a marginal purpose. Given this fact, the best role for those concerned with understanding fertility and mortality in developing nations is to press for the inclusion of, and then the careful tabulation and analysis of, census questions that allow indirect estimation of these parameters.

REFERENCES

Bangladesh (1977) Report on the 1974 Bangladesh Retrospective Survey of Fertility and Mortality. Dacca: Census Commission, Statistics Division, Ministry of Planning.

Bharier, J. (1968) A note on the population of Iran, 1900-1960. Population Studies 22(2):273-279.

Brass, W., A. Coale, P. Demeny, D. Heisel, F. Lorimer, A. Romaniuk, and E. van de Walle (1968) The Demography of Tropical Africa. Princeton, N.J.: Princeton University Press.

Brass W., and K. H. Hill (1973) Estimating adult mortality from orphanhood. In Proceedings of the International Population Conference, Vol. 3, pp. 111-123. Liege, Belgium: International Union for the Scientific Study of Population.

Cairo Demographic Centre (1970) Demographic Measures and Population Growth in Arab Countries. Research Monograph Series No. 1. Cairo: Cairo Demographic Centre.

Caldwell, J. C., and C. Okonjo, eds. (1968) The Population of Tropical Africa. London: Longmans, Green, and Co., Ltd.

Cho, L.-J. (1973) The own-children approach to fertility estimation: an elaboration. In Proceedings of the International Population Conference, Vol. 2. Liege, Belgium: International Union for the Scientific Study of Population.

Cho, L.-J., ed. (1976) Introduction to Censuses of Asia and the Pacific, 1970-1974. Honolulu: East-West Population Institute.

Coale, A. J., and P. Demeny (1966) Regional Model Life Tables and Stable Populations. Princeton, N.J.: Princeton University Press.

Ewbank, D. C. (1981) Age Misreporting and Age-Selective Underenumeration: Sources, Patterns, and Consequences for Demographic Analysis. Report No. 4, Panel on Data

Collection, Committee on Population and Demography, National Research Council. Washington, D.C.: National Academy Press.

Francese, P. K. (1979) The 1980 census: The counting of America. Population Bulletin 34(4).

Gibril, M. A. (1979) Evaluating Census Response Errors: A Case Study for the Gambia. Paris: Organisation for Economic Co-Operation and Development, Development Center.

Hill, K., and T. J. Trussell (1977) Further developments in indirect mortality estimation. Population Studies 31(2):313-333.

Hill, K., H. Zlotnik, and T. J. Trussell (1981) Indirect Techniques for Demographic Estimation. Committee on Population and Demography, Assembly of Behavioral and Social Sciences, National Research Council, National Academy of Sciences. (To be published as Manual X in the series of demographic analysis manuals of the Population Division, United Nations.)

Hobcraft, J. N. (1980) Illustrative Analysis: Evaluating Fertility Levels and Trends in Colombia. World Fertility Survey Scientific Reports, No. 15. London: International Statistical Institute.

Kamps, J. E. (1976) La Declaracion de la Edad en los Censos de Poblacion de la America Latina. Series C, No. 1004. San Jose, Costa Rica: Centro Latinoamericano de Demografia (CELADE).

Lotka, A. J. (1939) Theorie Analytique des Associations Biologiques. Paris.

Lotka, A. J., and Sharpe, F. R. (1911) A problem in age-distribution. Philosophical Magazine (United Kingdom) 21(124):435-438.

Madigan, F. C. (1973) The Mindanao Center for Population Studies: A Philippine POPLAB Report. Scientific Report Series No. 8. International Program of Laboratories for Population Statistics, Chapel Hill, S.C.: University of North Carolina.

Madigan, F., and A. Herrin (1973) Birth and Death Rates from Dual Records Project for January 1, 1972, to June 30, 1972. Report No. 9, Mindanao Center for Population Studies, Xavier University, Cagayan de Oro City, Philippines.

Marckwardt, A. M. (1973) Evaluation of an experimental short interview form designed to collect fertility data: The case of Peru. Demography 10(4):639-657.

Myers, R. J. (1940) Errors and bias in the reporting of ages in census data. Transactions of the Actuarial Society of America 41:2(104):411-415.

Nepal, Central Bureau of Statistics (1975) Population Census of 1971, Female Fertility Characteristics Tables. Katmandu: Central Bureau of Statistics.

Ohadike, P. O., and H. Tesfaghiorghis (1975) The Population of Zambia. Paris: Committee for International Coordination of National Research in Demography (CICRED).

Ominde, S. (1975) The Population of Kenya-Uganda-Tanzania. Nairobi: Committee for International Coordination of National Research in Demography (CICRED).

Organization of American States, Programa del Censo de America de 1970 (COTA-1970) (1977) Censos de Poblacion: Temas, Definiciones, Clasificaciones y Cuestionarios Utilizados por los Paises de la Region Americana. 76.XXIV.003S. Washington, D.C.: Organisation of American States.

Pison, G. (1978) Etudes Demographique dans la Region du Sine-Saloum (Senegal). Dakar: Office de la Recherche Scientifique et Technique Outre-Mer.

Population Reference Bureau (1980) 1980 World Population Data Sheet. Washington, D.C.: Population Reference Bureau.

Organisation for Economic Co-operation and Development (1980) Mortality in Developing Countries, Volumes I-VI. Prepared by R. Clairin, J. Condé, M. Fleury-Brousse, D. Waltisperger, and G. Wunsch. Paris: Organisation for Economic Co-operation and Development.

Quandt, A. S. (1973) The Social Production of Census Data: Interviews from the 1971 Moroccan Census. Ph.D. dissertation, University of California, Los Angeles.

Republique Tunisienne (no date) Recensement General de la Population et des Logements: 8 Mai 1975. Vol. III. Tunis: Institut National de la Statistique.

Republique Tunisienne (1973) Recensement de Population. May 1966, Vol. 1. Tunis: Institut National de la Statistique.

Shryock, H. S., Jr., J. S. Siegel, and Associates (1973) The Methods and Materials of Demography, rev. Washington, D.C.: U.S. Goverment Printing Office.

Sudan, Population Census Office (1977) Report of the Second Population Census, 1973, Vol. 1. Khartoum: Population Census Office.

Taeuber, C., and M. H. Hansen (1964) A preliminary evaluation of the 1960 Censuses of Population and Housing. Demography 1(1):1-14.

Tuygan, K., and T. Cavdar (1975) Comparison of self and proxy responses to questions related to children of ever-married women. In A. Adlakha, ed., Proceedings of the Seminar on the Design of the Turkish Demographic Survey, 20-22 February 1974, Ankara: Papers Presented, Chapter VI. Scientific Report Series No. 17, International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

United Nations (various years) Demographic Yearbook. ST/ESA/STAT/SER.R. New York: United Nations. (Published annually.)

United Nations (various issues) Population and Vital Statistics Report. Statistical Papers, Series A (ST/ESA/STAT/SER.A/). New York: United Nations. (Published quarterly.)

United Nations (1980) Principles and Recommendations for Population and Housing Censuses. Statistical Papers, Series M, No. 67, ST/ESA/STAT/SER.M/67. New York: United Nations.

United Nations, Department of Economic and Social Affairs (1974) Handbook of Population and Housing Census Methods, Part IV, Survey of Population and Housing Census Experience, 1955-1964. Series F, No. 16, ST/STAT/SER. F/16/Add 4. New York: United Nations.

United Nations, Economic and Social Commission for Asia and the Pacific (1974) The Demographic Situation in Hong Kong. ESCAP Country Monograph Series, No. 1, E/CN.11/1120. Bangkok: Economic and Social Commission for Asia and the Pacific.

United Nations, Economic and Social Commission for Asia and the Pacific (1980) Review of Demographic Sample Surveys in Asia and the Pacific, 1970-79, Publication No. ST/ESCAP/135. Bangkok: Economic and Social Commission for Asia and the Pacific.

United Nations, Economic Commission for Africa (1977) Study on Methods and Problems of the 1970 Round of African Population and Housing Censuses. E/CN.14/CAS.10/15. Addis Ababa: United Nations, Economic Commission for Africa.

United Nations, Economic Commission for Western Asia (1977) Demographic and socio-economic situation in countries of the ECWA region. Population Bulletin of the UNECWA 12:3-11.

United Nations, Economic Commission for Western Asia (1978) Private communication dated 2 March.

United Nations, Secretariat (1974) The availability of demographic statistics throughout the world. In *The Population Debate: Dimensions and Perspectives*, Vol. 1. pp. 371-384. ST/ESA/SER.A/57. Bucharest: United Nations.

United Nations, Statistical Office (1981) Dates of National Population and/or Housing Censuses (1965-1984). Unpublished listing dated 1 January, UNSO, New York.

U.S. Bureau of the Census (1971) *Population of Tunisia, Estimates and Projections: 1967-2000*. Series P-96, No. 3. Washington, D.C.: U.S. Government Printing Office.

U.S. Bureau of the Census (1976) *World Population: 1975*. ISP-WP-75. Washington, D.C.: U.S. Government Printing Office.

U.S. Bureau of the Census (1978) *World Population: 1977*. ISP-WP-77. Washington, D.C.: U.S. Government Printing Office.

U.S. Bureau of the Census (1980) *World Population: 1979*. ISP-WP-79. Washington, D.C.: U.S. Government Printing Office.

U.S. Bureau of the Census (various issues) Country Demographic Profiles, Series ISP-DP. Washington, D.C.: U.S. Government Printing Office. The following issues:

Chile (1978)
Costa Rica (1977)
Ghana (1977)
Guatemala (1977)
Honduras (1977)
Jamaica (1977)
Kenya (1978)
Panama (1977)
Sri Lanka (1977)
Taiwan (1978)
Thailand (1978)

3 The Civil Registration and Vital Statistics System

3.1 INTRODUCTION

Another approach to the collection of basic fertility and mortality data is through civil registration and vital statistics systems (CR/VS). This chapter reviews the state of the art of CR/VS systems and includes six sections: definitions and background; advantages of CR/VS; disadvantages of CR/VS; the status of systems in developing countries with regard to actual operating efficiency; attempts at improvements; and a summary.

There is a vast technical literature on civil registration and vital statistics systems, stretching as far back as the seventeenth century, when such systems began to be officially established on a national basis. There are also reports on even older systems that existed in parts of countries--for example, regional registration systems that operated 500 years ago in China, Japan, and Korea and the parish record systems of Europe, which have been used to estimate fertility and mortality. No attempt is made here to comprehensively review this literature, however some of the more relevant recent documents include the following: the various United Nations handbooks on vital registration (U.N., 1953, 1955, 1958, 1973), Methods for Measuring Population Change: A Systems Analysis Summary (Linder, 1969), Systems of Demographic Measurement, General Evaluation: The Measurement Problem (Linder and Lingner, 1975), Systems of Demographic Measurement, Data Collection Systems: The Conventional Vital Registration System (Powell, 1975), Organizational Arrangements for a Vital Registration System (Powell, 1977). Many of the points in the following discussion have been drawn from these documents.

3.2 DEFINITIONS AND BACKGROUND

The United Nations defines civil registration as "the continuous, permanent, compulsory recording of the occurrence and characteristics of live birth, death, fetal death, marriage, divorce, annulment, judicial separation, adoption, legitimation and recognition, as provided through decree or regulation, in accordance with the legal requirements in each country. Civil registration is carried out primarily for the value of the legal documents as provided by law" (U.N., 1973:156). The statistical uses of these records are also specified (U.N., 1973:17):

> The compilation of vital statistics should have as its ultimate minimal goal (1) the provision of total monthly or quarterly summary counts of live births, deaths, marriages and divorces (and of foetal deaths if these are included in the collection programme) on a time schedule prompt enough to provide information for administrative or other needs; and (2) the production of detailed annual tabulations of such type and on such time schedule as will make possible their effective use for scientific analysis of the interrelationship between demographic, economic, and social factors, for planning, operating and evaluating public health programmes, and for other purposes as required, particularly in regard to the formulation and evaluation of economic and social plans. In so far as possible, such statistics should be comparable on an international basis and lend themselves to international analysis.

Although civil registration systems by definition include vital events such as marriage, divorce, fetal death, adoptions, etc., the following discussion refers only to births and deaths. However, by extension, most of the points made below are generally applicable to other vital events.

3.2.1 The Special Case of Population Registers

It should be emphasized at the outset that this definition of a civil registration system does not extend to cover what is commonly termed a "population register." Generally maintained in the form of a ledger or computer file, a population register is a continuously updated file of basic demographic information for every individual in the population. It includes information on vital events and on the total population, and thus can provide the denominator data for calculating vital rates.

In general, a continuous population register is built from a base of census-type information to which continuous corrections and additions are made with data derived from a civil registration system and other administrative reports. Because of the necessity of making change-of-residence corrections, population registers typically are maintained at a local level. The method of extracting statistical information from a large number of local registers and consolidating it for national totals also varies from system to system. For a description of the many variations that exist in the design and purposes of such systems, see United Nations, 1962 and 1969.

The population register systems that operate most successfully are those in several northern and eastern European countries and the somewhat different Koseki system of Japan. Serviceable systems exist, for example, in the Netherlands, Denmark, Sweden, Israel, and Taiwan. In most instances the systems were not established for the purpose of creating statistics but for other administrative objectives; therefore, special efforts usually have to be taken to "align" the statistics derived from a population register with those obtained from censuses and surveys, even when the population register is considered essentially complete.

Population register systems are theoretically attractive because the same system produces data on the number of births and deaths as well as on the corresponding population base. However, the systems are highly sophisticated in that they require very precise input data, a disciplined and literate population that regularly reports changes in demographic status and location, and accurate procedures for matching records and compiling data from them. In addition, considerable resources are required to establish a population register, and there are many technical problems with maintaining it at an efficient level. As a result, it is of doubtful value as a method of collecting data for estimating fertility and mortality trends, levels, and patterns in any but a few special situations, situations rarely encountered in developing countries.

This is not to say that a population registration system does not have important purposes in either developing or developed countries. In fact, there is a significant trend toward establishing population identity numbers and national registers of such numbers, which can be useful for military conscription and health and social welfare programs, including social security. However, such registers frequently cover only certain segments of the population or have other major limitations that preclude their use as a major source of data on fertility or mortality rates. For example, such systems rarely include information on internal and international migration.

3.3 ADVANTAGES

The strength of any data collection system depends upon the quality of its statistical output, including content or variable coverage, geographic coverage, temporal coverage, and overall accuracy and completeness. In this regard, the special characteristics of CR/VS systems give them a number of advantages relative to other data collection methods. These include the legal rationale and strong legislative grounding of CR/VS systems, the fact that they provide documents that are of personal value to registrants, the broad geographic coverage they can provide, timeliness and associated gains in accuracy of data, and the administrative and cost benefits of operating as a part of an ongoing civil system.

3.3.1 History and Legal Rationale

Most countries have officially established civil registration systems that are continuous, permanent, and compulsory. A strong legislative basis for civil registration systems exists because registration has been and is still regarded as having primarily a legal rather than a statistical function. For example, civil registration records often provide the legal verification of an individual's eligibility for admission to public schools or qualification for work permits and assistance in old age. In addition, the documents generated by the system may be required for the disposition of dead bodies; may serve as a trigger for social or health programs, such as postpartum care for mothers; and may be used as a primary input to demographic or public health statistical programs.

The history of civil registration as a nationally organized process goes back to the seventeenth century; in more fragmentary and specialized forms, it dates to perhaps a thousand or more years before that. Very early registration systems were not designed to collect data on vital events that could be used as input to a statistical system; most were established for special purposes, such as those relating to conscription, revenue and taxation. Sometimes the systems were the concern of ecclesiastical authorities, who kept records of payments received for performing ceremonies such as baptisms or burials. (Some students of history suggest that civil registration as a nationally organized process began in the sixteenth century, with the almost simultaneous ordinances by Thomas Cromwell in 1538 for England and of Villers-Cotteret in 1539 for France. The former required Anglican priests to make weekly entries of burials, weddings, and baptisms; however, these entries were not complied into statistical totals for all of England.)

Although it is difficult to be precise, it would seem that at least 16 sovereign countries plus some non-sovereign areas established compulsory registration systems prior to 1850. (Although compulsory, these systems were not necessarily complete.) These nations were primarily the countries of Europe and those following the principles of the Napoleonic Code (1804). Some of the systems began before 1804. For example, the registration of births, deaths, and marriages became compulsory by law in Finland in 1628, Denmark in 1646, Norway in 1685, Sweden in 1686, and France in 1792 (United Nations, 1955:20). In Mauritius the first important legislation relating to the establishment of the civil registry for births, deaths, and marriages is the Royal Ordinance of 1667, although the first legislation devoted exclusively to the registration of these events is the Royal Declaration of 1736, registered in 1737 in the Superior Council of Ile de France (the former name of Mauritius). Between 1850 and 1925 more than 50 additional countries enacted legislation establishing a compulsory system of civil registration. This number includes some non-sovereign territories or colonies; in some cases the systems were only partial registration systems, covering certain geographic sections of the territory or selected ethnic groups.

A great deal of information about both the history and current status of civil registration and vital statistics systems was collected in a study conducted in 1977 by the United Nations. Table 3.1 summarizes some of the provisional results of that study, including information on the time of implementation of legislation establishing CR/VS systems. By 1925, 71 of the 100 countries or areas reporting had implemented CR/VS systems, including 8 in Africa, 10 in Asia, and 20 in Latin America. Another 7 countries implemented legislation in the period 1925-45, and 21 more during the post-1945 period, including 11 countries in Africa and 5 in Asia.

Table 3.1 also presents the characteristics of existing CR/VS systems, as reported in 1977. In Africa, Asia, and Latin America, nearly 90 percent of the systems have compulsory requirements for registration of vital events. One country in Asia has voluntary registration, and in six African countries the situation is mixed. (In some, this means that registration is compulsory for some ethnic groups but not for others; in others, it means the country is gradually expanding the geographic areas in which registration is compulsory.) Among the reporting countries, geographic coverage is total in all but seven countries in Africa. Nearly all the reporting countries outside of Africa compile and publish the vital statistics obtained on births and deaths. In Africa, 14 of the 20 reporting countries compile these vital statistics and 13 countries publish them.

The legal force behind registration systems is being strengthened by national legislation that requires individuals to have documented proof of birth or death as well as by international actions of a legislative character. For example, Resolution 2200(XXI) of the International Covenant on Civil and Political Rights, adopted by the General Assembly of the United Nations on 16 December 1966, states: "Every child shall be registered immediately after birth and shall have a name." Many other U.N. actions, entirely apart from statistical recommendations, state or imply the necessity for civil records.

(For a more detailed legal history of registration, see United Nations, 1955:3-5 and Powell, 1975:12-15.)

3.3.2 The Personal Value of Civil Registration Documents

In sharp contrast to other demographic data collection systems, the CR/VS systems create documents that are extremely valuable to the person to whom the document relates. In general, the value of the documents is closely tied to the legal underpinning of the registration system. The following excerpt from a United Nations publication (1973:4) indicates the wide range of needs such documents meet:

> For the individual, the civil registration records of birth provide legal proof of identity and civil status (including name, parentage, ancestry or lineage); age; nationality (citizenship); dependency status; legitimacy status; etc. on which depend a wide variety of rights, particularly in regard to the exercise of civil functions, entitlement to family allowances, care of children, tax deductions, insurance benefits, education, and other benefits; property ownership and inheritance, etc. The death records provide legal evidence relevant to claims to inheritance of property, to insurance on deceased persons, to rights of surviving spouse to remarry, to claims for family allowances where the death creates financial needs, etc. Marriage and divorce records are the basis for claims involving the status of women, such as dependency and alimony allowances, tax deductions, provision and allocation of specific types of housing and numerous other facilities which relate to a married man and his wife, including claims to a change of nationality on the basis of marriage. Divorce records are most important to establish the right to remarry.

A dramatic illustration of how heavy a demand there is for such documentation was provided by a recent article in a Chilean newspaper. Accompanied by a photograph that showed hundreds of persons lined up in front of the Chilean Central Registration Office to request birth certificates, the article reported that 4,500 to 5,000 copies of registration documents were being issued daily. The normal load at the office was 1,200 copies daily. The heavy demand at that particular time was due to the need to present a birth certificate to gain entrance to school. The more people need civil registration documents to function legally within society, the more likely they are to register; the fact that they have something personally at stake encourages compliance.

The pressing need for registration records also encourages governments to improve their CR/VS systems as quickly as possible and has made complete registration of certain vital events a high-priority goal in many developing countries. For example, the individual need for birth certificates is an important element in the relative completeness of birth registration in Egypt, Tunisia, Sri Lanka, and Peninsular Malaysia.

3.3.3 Geographic Coverage, Timeliness, and Accuracy

Since a civil registration system is based on established administrative uses of records, the system usually is legally in force throughout the national territory. This means that CR/VS data, like census data, can be used to produce national totals as well as totals for states, provinces, municipalities, and every civil subdivision down to the smallest village. However, unlike a census, a registration system produces a continuous flow of data rather than temporal cross-sections of a country's demographic status. CR/VS systems measure the incidence rather than the prevalence of vital events. This continuous flow of data permits monthly and quarterly reports as well as annual tabulations and also offers the administrative advantage of a data processing effort that is spaced evenly over time, except in cases of year-end spurts in registration.

A parallel advantage of CR/VS systems is that legislation usually requires that a vital event be registered within a short time after it occurs. Therefore some summary registration data useful for estimating fertility and mortality can be made available on a fairly up-to-date basis. For example, the Tunisian government, through its Institute of National Statistics, publishes a monthly statistics bulletin that shows registered births, deaths, and marriages by months of occurrence for 18 administrative divisions in the country (gouvernorats). These bulletins generally report data by month for the 13 months ending approximately three months before the month of publication.

The legal requirement that vital events be registered soon after they occur also means that in countries with relatively complete and timely registration, data are reported within a short recall period. This is a particular advantage in collecting fertility and mortality data, because it has been found in general that the shorter the recall period, the more accurate and complete the information. Another characteristic that tends to contribute to accuracy of registration data is the fact that civil registration acts are legal depositions, in which information usually is provided by persons closely associated with the individual whom the event concerns--often the parents, spouse, children, or attending medical personnel.

3.3.4 Administrative and Cost Advantages

Because of its legal and nationwide character, a registration system has the strong advantage of being administered through a local infrastructure that is continuously in place. The system operates through a network of hundreds or thousands of local government offices that in most countries exist continuously, although usually they do not exist exclusively for the registration of vital events. This network gives a certain stability to the system and makes it possible to effect changes and improvements gradually.

Because of the ongoing administrative character of the systems, the cost of document collection is routinely incorporated into regular governmental budgets. However, this routine provision of funds does not always cover the tabulation or other statistical aspects of the process, which are often subject to the same kind of fiscal vicissitudes and reporting delays as censuses or surveys.

It is almost impossible to appraise the costs of civil registration. Actual costs cover many elements, from the time and effort spent on basic design decisions to overhead costs related to physical facilities, equipment, and support services. However, the cost of administering a CR/VS system often seems low relative to the cost of other data collection systems. One reason is that many of its costs are shared costs, in that the same resources are used concurrently for more than one activity. Also, many of the costs may be considered built-in or mandatory costs, in that they would continue even if the civil registration system did not exist. For example, the costs of local government administration would continue with little change even if civil registration were not one of its tasks (Linder and Lingner, 1975:21-22).

3.4 LIMITATIONS

Along with its strengths, the CR/VS system has certain inherent and practical limitations as a source of fertility and mortality data. Among the major limiting factors are the level of incompleteness of a system, the fact that registration cannot provide the denominator data needed for calculating vital rates, the requirements for an efficient reporting network, and the necessarily narrow range of types of data collected.

3.4.1 Level of Incompleteness

The basic limitation of most CR/VS systems as a source of data for estimating levels and trends of fertility and mortality in developing nations is that in many of these countries they are currently incomplete. Furthermore, the extent of underregistration frequently is unknown or at best is known only within a substantial range of error. The solution to this problem is partly a question of time; it usually takes some decades to develop a registration system that is virtually complete in terms of registering all vital events. However, demographic techniques for estimating levels of completeness of registration have improved in recent years, making possible better use of incomplete data. It must be emphasized, though, that these methods tend to leave the user with fairly wide ranges of uncertainty; also, they are subject to errors of assumption as well as errors in the data (see Hill et al., 1982). Knowing use of such techniques, however, can provide the basis for reasonably good estimates based on registration data, particularly when other data sources are also incomplete or otherwise flawed. Even a registration system that is only 60 percent complete in terms of registering deaths of persons aged 10 and over often provides the best available basis for estimating adult mortality.

Direct checks on the completeness of registration have been undertaken in some countries, by means of sample surveys, e.g., Egypt in 1974-75. Through relatively inexpensive periodic checks of a sample of areas or households, the entire product of a national registration system can be mobilized. Much of the value of registration data in LDCs depends on whether the direct and indirect checks are carried out competently.

A recent study of Egyptian fertility and mortality trends used census data and indirect estimation techniques to construct estimates of the completeness of birth and death registration in Egypt (National Research Council, 1981). The results of the recent study show that birth registration was about 96 percent complete during 1972-75, and that since 1960 the registration of deaths among persons above age 10 was about 100 percent complete for males and about 85 percent for females. The registration of infant deaths is much less complete, about 75 percent for the country as a whole in 1975-76 with a range from just above 50 percent in rural Upper Egypt to above 98 percent in Cairo and Alexandria.

3.4.2 Dependence on Other Data Sources for Denominator Data

Another limitation of the CR/VS system as a basis for fertility and mortality estimation is that it does not provide all the data necessary to compute birth and death rates. A good registration system can produce data on the number of births and deaths for national and subnational areas on a current basis, but these data represent only the numerators of the rates. The other component of the rates--namely the denominators, which indicate the population exposed to risk--must come from a source outside the registation system itself.

Most countries that conduct a periodic population census can produce a population denominator for the country as a unit and for subdivisions of the national area for the time of the census. And estimation procedures often make it possible to provide reasonably accurate population estimates for the total national area for intercensal and postcensal years. However, it is difficult to produce such estimates for subnational geographic units, except for years in which censuses are taken (or years just before and after census years) because of difficulties in measuring internal migration. Thus, unless the statistical output of a registration system is developed in close coordination with the output of the census organization, for example by having common geographic boundaries for census areas and for registration areas, the value of a registration system as a source for demographic rates is greatly weakened.

The disadvantage of a CR/VS system having to depend on external data sources for denominator information is tempered in situations in which it is possible to estimate adult mortality, or mortality above about age 10, in the absence of denominator information. This can be done even when the registration of deaths is considerably less than 100 percent, for example, as little as 60 to 80 percent complete. Brass (1975) and later Preston and Hill (1980) and Preston et al. (1980) have developed techniques for estimating adult mortality using incompletely registered death data and selected other information. All these methods require the acceptance of certain assumptions. The Brass method requires an age distribution of the population and three assumptions: (1) the population is stable; (2) the age at death is recorded correctly or nearly so; and (3) the omission of deaths is approximately constant with age. The Preston-Hill method requires two age distributions at different points in time but does not require the assumption that the population is stable. The Preston et al. method requires an estimate of the population growth rate and the assumption of stability, but assumptions 2 and 3 (noted above) are not necessary. Examples of countries where at least one of these methods has been applied successfully include Brazil, Egypt, South Korea, El Salvador, and a 1929-31 sample of Chinese farmers.

3.4.3 The Need for Well-Organized Reporting Networks

In a few systems, the primary legal responsibility for reporting births and deaths falls on the attending physician, the hospital, the funeral director, etc. However, in most systems this responsibility is placed on the parents or relatives and only secondarily upon attendants or official registrars. Some developing nations have established legal procedures requiring burial permits, which then become the basis for the official registration of deaths.

A registration system functions well only if the public is aware of its responsibilities and understands the value of compliance, and if it is reasonably convenient for the person responsible for registration to fulfill that obligation. Madigan and Herrin (1977:6) have stated the problem well:

TABLE 3.1 Type and Time of Implementation of Civil Registration/Vital Statistics Systems, Classified by Region

		Government Provisions for Civil Registration									Vital Statistics		
		Period of Implementation of Enacted Legislation[a]				Type of System			Coverage		Compiled		Published
Region	Number of Countries Reporting	1925 or Earlier	1926–1945	1946–1965	1966 or Later	Compulsory	Voluntary	Mixed[b]	Total	Partial	Births	Deaths	
Africa	20	8	1	6	5	14	0	6	13	7	14	14	13
Asia (except Japan and Israel)	17	10	2	3	2	16	1	--	17	--	15	15	15
Latin America	23	20	3	--	--	23	--	--	23	--	23	23	23
Oceania (except Australia and New Zealand)	5	1	1	2	1	5	--	--	5	--	4	4	3
Subtotal	65	39	7	11	8	58	1	6	58	7	56	56	54
Europe	29	26[c]	--	2	--	29	--	--	29	--	29	29	29
Other Developed	6	6	--	--	--	6	--	--	6	--	6	6	6
Total	100	71	7	13	8	93	1	6	93	7	91	91	89

[a] In most cases the year of enactment and year of implementation are the same. In a few cases the year of enactment was a few years earlier than the year of implementation.

[b] Includes countries where registration is compulsory for some ethnic groups but not for others and cases where the country is gradually expanding the geographic areas in which registration is compulsory.

[c] If Faeroe Islands were included, the total would be 27. The U.N. study indicated the timing of the Faeroe Islands registration system as unknown, but on the basis of other information, it seems probable that the legislation was implemented before 1925.

Source: Derived from provisional results of a study on civil registration/vital statistics practices conducted in 1977 by the United Nations.

> Good censuses can be taken by governments willing to pay the costs in consultation, training of personnel, careful execution of the census and analysis of its data. But the establishment, or the upgrading (where a system already exists), of a registration system (where households report births and deaths to the government), depends as much upon the understanding and cooperation of the citizenry as upon the registration officials. Where roads do not exist to link many villages with the town center, where distances are great between potential reporters of vital events and government offices in which the event should be reported, where attendance of a physician or nurse at a birth or death is unusual, and where considerable time and effort in making the trip to town are required to register an event, registration is likely to seriously underreport the number of vital events. The situation is not likely to improve until roads and other related infrastructure also improve. Some have said this will require 20 years. Others have called such statements optimistic.

One could add to this list of barriers the fee for registration that exists in some countries, particularly the cost of registering a birth or obtaining a birth certificate.

Improving the completeness of registration is likely to require the gradual transfer of the reporting responsibility to hospitals, physicians, and others acting officially on behalf of the government, as well as the establishment of comprehensive networks of local registration offices, located and administered so the public can more readily comply with its responsibilities for registering vital events. Some countries have tried to initiate CR/VS systems by staffing them with local registrars who have either full-time or part-time responsibility for registration. Examples include the chowkidars in India and Bangladesh, the Kepala Desa in Indonesia, and the penghulus in Malaysia.

While the efficient maintenance of a comprehensive network of local offices permits gradual improvement, the possibility of slow deterioration also exists. Not infrequently it is easier to generate enthusiasm and vigorous efforts for a major ad hoc project like an occasional census or survey than it is to maintain a high level of efficiency in an enterprise that operates routinely.

3.4.4 Scope of Coverage of Related Variables

The civil registration system exists originally and primarily as an official method of establishing the legal fact of birth and death; the statistical uses of the system are secondary. Accordingly, many items on registration documents are there essentially to establish identity and family relationships and other legal characteristics of the vital event, and have little value as analytical variables relevant to studying population change. Other items on the documents are evidentiary in nature, such as the signatures of witnesses. The priority of items, in combination with the administrative necessity of keeping the total number of items limited, results in a registration document that produces the basic facts of demographic change, but which provides information on few variables relating to the economic, social, and cultural aspects of such change. The restrictive nature of the legal document is not always a limiting factor, since in some countries vital statistics are compiled not exclusively from civil records but from other sources as well (Cavanaugh, 1963:18).

In its 1953 publication Principles for a Vital Statistics System, the United Nations suggested 19 statistical variables to be included on a birth registration record, 10 of which were designated first-priority items. A 1973 revision of the principles (United Nations, 1973) expanded the list to 37 variables, of which 12 were considered first priority. This expanded list appears in Table 3.2. A serious constraint on demographic analysis of registration data is that longitudinal variables--such as the time interval since the last previous birth and other birth intervals--usually are not included on birth registration forms, though there are exceptions. For example, in accordance with the U.N. recommendations, some countries collect parity data on the birth registration forms, then tabulate data on births classified by parity of mother, information that is particularly helpful in analyzing trends in fertility. Egypt collects and tabulates data on live births classified by duration of marriage of mother, which makes it possible to estimate duration-specific fertility rates.

Seven of the priority birth items listed in Table 3.2 are directly useful for estimating levels and trends of fertility, plus one of the other 25 items, not including those associated with estimating fertility differentials, such as educational attainment and occupations of parents. Among the death items, six of the nine priority items are useful for estimating mortality levels and trends.

3.5 CURRENT STATUS OF CR/VS SYSTEMS

Despite the various difficulties in using registration data, many countries rely on CR/VS systems to supply information on births, deaths, and other vital events. Table 3.3 classifies 96 countries in six regions by source of vital registration data. The three sources shown are a civil registration system, a sample registration area scheme (which utilizes registration data from a subsample of the civil registration area), and a sample survey. As indicated, the use of CR/VS systems is widespread. Among the 96 countries, 88 depend on CR/VS systems for data on births and deaths; 68 for data on fetal deaths; and 81 and 61, respectively, for marriage and divorce data. Only three reporting countries use sample registration area systems to obtain birth and death data. Less than 20 countries use sample surveys to obtain birth and death data; in some of these countries, the surveys are used in addition to the CR/VS system. (A great many countries use surveys to obtain additional information on mortality and especially fertility, as described in Chapter 4.)

3.5.1 Organizational Differences Among Countries

The way in which civil registration and vital statistics systems are organized and administered varies widely. In a few countries, the responsibility rests with health ministries; in some, the responsibility for both registration and statistics rests with a central national agency, such as the Registrar General's Office; in others, registration may be overseen by the Ministry of the Interior (being handled as a local government function) or by the Ministry of Justice (as a judicial function) or by some other governmental entity, while vital statistics are the responsibility of a Central Statistical Office. Table 3.4, which shows the distribution of responsibilities for administering or monitoring civil registration and for compiling vital statistics in 102 countries, reveals the many different combinations in use as of 1977.

This organizational heterogeneity among CR/VS systems in different countries has tended to inhibit the evolution of a widely accepted, international professional organization for those who manage such systems. In contrast, general-purpose statistical agencies, though also not uniform from country to country, generally have much more similar patterns of organization and function. This has facilitated the development and implementation of internationally standardized concepts, for example, the almost universal and reasonably standardized application of the population census.

The heterogeneity of agencies responsible for national vital registration is also an obstacle to the international dissemination and exchange of technical information on new methods and the application of improved techniques. There is no international intergovernmental agency that serves as a forum where the varied group of statisticians, health officials, judicial officials, and local government officials can exchange information and ideas about CR/VS systems. This international heterogeneity is reflected in the United Nations, too, where responsibility for coordinating information about CR/VS systems is dispersed among various units, which has retarded development of U.N. programs for establishing more internationally uniform systems.

3.5.2 Dispersal of Responsibility Within a Country

Much more important from the standpoint of an individual country is how the operation of its system is affected by dispersal of responsibility for different tasks among different agencies within the government. In the 102 countries represented in Table 3.4 responsibility for compiling vital statistics rests with the Central Statistical Office in 79 cases; however, of these, only 4 have responsibility for civil registration as well. Looking at the table from another axis shows that

TABLE 3.4 Government Agencies Responsible for Civil Registration and Compilation of Vital Statistics at the National Level: 102 Countries

Agency with National Responsibility for Compiling Vital Statistics	Agency with National Responsibility for Civil Registration					
	Central Registration Office[a]	Central Health Office	Central Statistical Office	No Central Responsibility[b]	Not Ascertained	Total
Central Registration Office	9	--	--	--	--	9
Central Health Office	3	4	--	2	--	9
Central Statistical Office	46[c]	5	4	22	2	79
Not Compiled at the Time of the Study	3	--	--	1	--	4
Not Ascertained	1	--	--	--	--	1
Total	62	9	4	25	2	102

[a] Ministry of Interior, Registrar General's Department, Ministry of Municipalities, Ministry of Justice, Ministry of Home Affairs, etc.

[b] Includes cases "not ascertained" but where civil registration at subnational level was indicated in survey.

[c] In one case (Syrian Arab Republic), separate agencies are responsible for civil registration and compilation of vital statistics, but both agencies operate under the Ministry of Interior. Similar arrangements may exist in a few other cases, but detailed information is not available on the ministries in which the agencies may be located. However, the most common pattern is separate agencies in different ministries.

Source: Derived from provisional results of a study on civil registration/vital statistics national practices conducted in 1977 by the United Nations.

TABLE 3.2 United Nations Recommendations for Items to be Included in Civil Registration Records

Part A. Births

	Data on Event	Data on Child	Data on Mother	Data on Father
Priority Items	*Date of delivery *Date of registration Place of occurrence (urban/rural) Type of birth (single or multiple issue) Attendant at birth	*Sex Legitimacy status Weight at birth	*Age *Children born alive during entire lifetime *Duration or date of marriage (for legitimate births) *Place of usual residence (urban/rural)	
Other Items	Hospitalization	Gestational age	Children born during entire lifetime and still living Fetal deaths during entire lifetime *Interval since or date of last previous live birth Educational attainment Literacy status Ethnic (and/or national) group Citizenship (nationality) Type of economic activity Occupation Duration of residence in usual (present) place Place of residence at a specified time in the past Place of birth	Age or date of birth Place of usual residence (urban/rural) Educational attainment Literacy status Ethnic (and/or national) group Citizenship (nationality) Type of economic activity Occupation Duration of residence in usual (present) place Place of residence at a specified time in the past Place of birth

* Items useful for estimating levels and trends in fertility.

Part B. Deaths

	Data on Event	Data on Decedent
Priority Items	**Date of occurrence	**Age
	**Date of registration	**Sex
	Place of occurrence	Marital status
	**Cause of death	**Place of usual residence
	Certifier	
Other Items	Hospitalization	Legitimacy status (for deaths under 1 year of age)
	Attendant at birth (for deaths under 1 year of age)	Was birth registered? (for deaths under 1 year of age)
		Duration or date of marriage (if married)
		Age of surviving spouse (if married)
		Children born during entire lifetime (for females of child-bearing age and over)
		Children born during lifetime and still living (for females of child-bearing age and over)
		Educational attainment
		Literacy status
		Ethnic (and/or national) group
		Citizenship (nationality)
		Type of economic activity
		Occupation
		Place of residence at a specified time in the past
		Place of birth

** Items useful for estimating levels and trends of mortality.

Source: United Nations (1973).

TABLE 3.3 Sources of Vital Statistics Data: Number of Countries that Obtain Vital Statistics from Civil Registration Systems, Sample Registration Area Systems, and Sample Surveys, Classified by Region and Type of Vital Event

Region	Number of Countries Reporting	Type of Data Collection System															
		Civil Registration					Sample Registration Area System						Sample Survey				
		LB	De	FD	M	Div	LB	De	FD	M	Div	P	LB	De	FD	M	Div
Africa	19	15	15	7	12	7	1	1	0	0	0	5	7	7	0	4	3
Latin America	23	23	23	18	23	7	0	0	0	0	0	5	5	4	1	1	1
East and South Asia	14	12	12	9	10	6	1	1	1	0	0	3	4	4	1	1	1
West Asia[a]	5	5	5	3	4	4	1	1	0	0	0	1	1	1	0	0	0
Europe	28	28	28	26	28	24	0	0	0	0	0	0	0	0	0	0	0
Oceania	7	5	5	5	4	3	0	0	0	0	0	2	2	2	0	1	1
Total	96	88	88	68	81	61	3	3	1	0	0	16	19	18	2	7	6

Key: LB = Live births
De = Deaths
FD = Fetal Deaths
M = Marriages
Div = Divorces
P = Population

Note: Some countries obtain data from more than one source.

[a] Includes Iraq, Israel, Jordan, Kuwait, and Syrian Arab Republic.

Source: Derived from provisional results of a study on civil registration/vital statistics national practices conducted in 1977 by the United Nations.

national responsibility for civil registration rests with a Central Registration Office in 62 countries, but in only 9 instances is that office also responsible for compiling vital statistics. All in all, only 17 of the 102 countries assign responsibility for both registration and compilation to the same national agency. However, in some countries it may be advantageous to have a division of responsibilities, because the collection can be handled most efficiently through a country-wide administrative network, while the statistical expertise for tabulation and analysis may exist only in a central statistical office. Such a division of labor, however, calls for close coordination between the two major responsible units.

A serious problem is that apparently in 25 of the 102 countries there exists no national agency that has clear responsibility for monitoring or improving civil registration. In many of these cases, registration is handled at a local level, through civil administrative or judicial offices. In such cases there may be a national ministry that has nominal jurisdiction over registration, but that jurisdiction may be melded, in an almost inseparable way, with numerous other aspects of local administrative work.

Table 3.4 indicates that there are many different ways of distributing CR/VS responsibility at a national level in countries that are governed as a single, geographic entity. An additional complicating factor arises in countries that are federations of states or provinces. There the distribution of powers between the national government and the provincial governments may vary widely. In some cases, registration may be the exclusive domain of the provinces; in others there may be some more or less well defined central government role as well.

3.5.3 Availability and Quality of Data

As noted earlier, incompleteness is probably one of the biggest problems with registration data, and the relative completeness of data in different countries is thus a major issue in comparative analysis. For example, a particular statistic, such as births classified by age of mother, may be available for one country in which the CR/VS system records 70 percent of the births, and for another country in which the CR/VS system records nearly all births. To develop reasonable estimates based on these data, analysts need to know how complete they are.

To help clarify this issue, the United Nations has defined three broad categories of completeness. A country is classified "C" if its CR/VS data are "estimated to be virtually complete, that is, representing at least 90 percent of the events occurring each year"; "U" (for underregistered) if the data are "estimated to be incomplete, that is, representing less than 90 percent of the events occurring each year"; and "...." in cases "for which no specific information is available regarding completeness" (UNDY 1978:11). (In the tables presented below, for countries in which there are two reporting areas or groups, for example, a country with a "C" for the European population and "U" for the national population, the classification has been made on the basis of the estimated completeness of the combined population.)

A weakness of this classification scheme is that the information on which the classifications are based is supplied by the reporting countries. To increase the meaningfulness of the classifications, the U.N. Statistical Office is encouraging countries to provide more information on how they arrive at their estimates of completeness of registration. In addition to the question of how the estimates are derived by each country, there is the considerable difference that exists between an estimated completeness level of 90 percent and one of 99.5 percent. If more information can be provided, the U.N. hopes to generate two classes of "C": soundly based estimates, and other estimates.

Table 3.5 shows the completeness classifications for birth and death registration reported by some 200 countries and published by the United Nations in 1961, 1971, 1978, and 1981. Although the level of registration completeness increased in some individual countries, the total number of countries reporting birth and death registration completeness levels of 90 percent or more did not increase very much during that 20-year period. The total number of countries with "C" levels of birth registration changed from 81 in 1961 to 92 in 1981, and only half of the increase was in developing-nation regions. For deaths, the pattern was similar: nine countries were added to the "C" category between 1961 and 1981, and seven of these countries are in Europe and "other developed" regions.

Table 3.6 shows what percentages of the world population and the population in developing regions live in countries for which data are available on selected variables related to registered births and deaths, circa 1975. For each region and the world, separate percentages are shown for the proportion of the population living in countries classified "C" and for the proportion in countries classified either "C" or "U." For example, annual totals for the number of reported births are available for 37 percent of the world's population ("C" and "U" countries combined); but only 29 percent of the world's population lives in countries in which 90 to 100 percent of the births are reported as registered in CR/VS systems. In Africa, 24 percent of the population lives in countries classified as either "C" or "U," while only 16 percent lives in "C" countries. For data on births classified by specific variables, the percentages are even lower. In Asia, for example, only 8 percent of the population lives in countries classified "C" or "U" for data on births by age of mother, a variable essential for estimating age-specific fertility rates. Only 1 percent of the Asian population lives in countries for which those data are classified "C."

An intriguing question not answered by Table 3.6 is what proportion of births in the world are registered in CR/VS systems. For the world as a whole it is probably around 40 percent, depending largely upon the completeness of birth registration in China. China is not included in Table 3.6 because its vital statistics were not reported to the U.N. for international publication in the 1978 U.N. Demographic Yearbook. However, there is some evidence that vital events in China, especially births, are recorded at least at a local level.

Table 3.6 also shows comparable percentages for death statistics, which are roughly similar to those for births. This is not unexpected, given that both sets of statistics are taken from the same basic CR/VS systems, however there are countries for which birth registration is "C" and death registration is "U" (e.g., Jordan and Tunisia), and Mexico is classified as "U" for births and "C" for deaths (PVSR, January 1981). However, the percentages shown for deaths classified by specific combinations of important variables (such as cause, and age and sex) are slightly lower relative to the percentages for comparably important combinations of variables for births (such as age of mother and sex of child).

TABLE 3.5 Reported Levels of Completeness of Birth and Death Registration: Number of Countries Classified by Region, 1961-81, from United Nations Sources

	Data Source															
	UNDY 1961				UNDY 1971				UNDY 1978				1 Jan 81 PVSR			
Vital Events by Region	C	U	...	Total	C	U	...	Total	C	U	...	Total	C	U	...	Total
Births																
Africa	6	16	26	48	7	9	38	54	7	4	41	52	7	13	36	56
Asia	7	16	11	34	8	8	19	35	6	4	26	36	7	11	23	41
Latin America	28	14	3	45	25	14	4	43	26	10	7	43	29	14	3	46
Oceania	6	4	8	18	7	2	11	20	8	2	5	15	9	3	14	26
Subtotal	47	50	48	145	47	33	72	152	47	20	79	136	52	41	76	169
Europe	27	1	7	35	30	0	4	34	31	0	0	36	32	0	5	37
Other Developed	7	0	1	8	7	0	1	8	8	0	0	8	8	0	0	8
Total	81	51	56	188	84	33	79	194	86	20	79	180	92	41	81	214

Deaths																
Africa	5	20	23	48	5	10	39	54	5	5	42	52	6	14	36	56
Asia	9	14	13	36	7	9	19	35	6	6	24	36	6	12	23	41
Latin America	27	14	4	45	24	15	4	43	26	13	5	44	29	14	3	46
Oceania	6	4	10	20	6	3	11	20	7	3	5	15	8	4	14	26
Subtotal	47	52	50	149	42	37	73	152	44	27	76	147	49	44	76	169
Europe	27	1	8	36	30	0	4	34	32	0	4	36	32	0	5	37
Other Developed	6	1	1	8	7	0	1	8	8	0	0	8	8	0	0	8
Total	80	54	59	193	79	37	78	194	84	27	80	191	89	44	81	214

Note: C = data estimated by reporting country to be virtually complete, that is, representing at least 90 percent of the events occurring each year.
U = data incomplete (underregistered), that is, representing less than 90 percent of the events occurring each year.
... = data for which no specific information is available regarding completeness.

Sources: As indicated.

TABLE 3.6 Percentage of World and Region Population Living in Countries for Which Selected Fertility and Mortality Information is Available from CR/VS Systems Classified by Levels of Completeness of the CR/VS Systems: Circa 1975

Type of Information	Percent of World Population[a] Living in Countries Classified:		Percent of Population in Developing Region Living in Countries Classified:					
			Africa		Asia		Latin America	
	C or U	C Only	C or U	C Only	C or U	C Only	C or U	C Only
Live Births								
Annual totals	37	29	24	16	8	1	66	22
Reported live birth classified by:								
Sex	28	27	20	16	8	1	66	22
Age of mother	28	27	24	16	8	1	66	22
Birth order	26	25	12	12	5	1	65	21
Birth order by age of mother	26	25	6	6	5	1	50	10
Legitimacy	20	19	12	11	0	0	30	13
Urban/rural residence	27	25	2	2	0	0	5	1
Legitimate births by age of mother	18	18	14	12	2	0	61	19
Type of birth (single, twin, etc.)	18	17	2	2	2	0	23	11
Age of mother and sex of child	25	25	12	12	5	1	50	10
Age of father	13	13	7	6	1	1	32	8
Duration of marriage	18	18	11	10	5	1	17	13

Deaths								
General Mortality								
Annual totals	36	30	20	10	7	2	58	41
Reported deaths classified by:								
Age and sex	25	23	15	10	7	2	53	41
Cause of death	25	12	13	10	7	2	53	41
Cause and sex	24	21	7	0	6	1	51	33
Marital status, age, and sex	29	27	13	10	3	1	22	12
Urban/rural residence	23	21	2	0	3	1	42	31
Occupation and age	33	29	20	10	8	1	58	41
Infant Mortality								
Annual totals	34	27	19	0	6	1	51	13
Reported infant deaths classified by:								
Age and sex	25	22	19	0	6	1	51	13
Urban/rural residence	28	27	0	0	1	0	14	2

Notes: A similar table, reflecting the status of data availability circa 1970, was published by the U.N. in 1974. See attached list of countries classified as "C" or "U", which was used to prepare the percentages shown above.

[a] The denominator used was the 1975 world population (3,967,005,000); numerators were taken from the 1977 UNDY, 1977 estimates, or most recent census figure.

TABLE 3.6 (continued)

Countries Whose Registration Data Are Rated "C" or "U" for Selected Variables of Births, General Mortality, and Infant Mortality

Africa	
"C"	"U"
Algeria*	Angola[1]
Cape Verde	Kenya
Egypt	Libya
Mauritius	Mozambique
Reunion	Rwanda*
Seychelles	
Tunisia*	

Latin America	
"C"	"U"
Antigua	Belize
Bahamas	Cayman I.
Barbados	Dom. Rep.
Bermuda	Honduras
Br. Virgin I.	Mexico[3]
Costa Rica	Neth. Ant.
Cuba	Nicaragua
Dominique	Bolivia
El Salvador	Colombia
Grenada	Ecuador
Guadelupe+	Fr. Guiana
Guatemala	Peru
Jamaica	Venezuela
Martinique*	
Montserrat	
Panama	
Puerto Rico	
St. Kitts	
St. Lucia	
St. Pierre+	
St. Vincent	
Trinidad-Tobago	
U.S. Virgin I.	
Argentina*+	
Chile	
Guyana	
Uruguay	

Oceania	
"C"	"U"
Amer. Somoa	Figi
Christmas I.	Pacific I.
Cocos I.	W. Samoa
Guam	
Nauru	
Norfolk	
Cook I.	

Europe	
"C"	
Albania[2]	Ireland
Austria	Isle of Man
Belgium	Italy
Bulgaria	Luxembourg
Channel Is.	Malta
Czechoslovakia	Netherlands
Denmark	Norway
Faeroe I.	Poland
Finland	Portugal
France	Romania
Germany, D.R.	San Marino
Germany, F.R.	Spain
Gibraltar	Sweden
Greece	Switzerland
Hungary	United Kingdom
Iceland	Yugoslavia

Asia	
"C"	"U"
Brunei	Iran
Hong Kong	Iraq
Jordan*	Lebanon
Kuwait	Philippines
Malaysia[4]	Syria
Singapore	Thailand
Sri Lanka[5]	

Other Developed
"C"
Australia
Canada
Greenland
Israel
Japan
New Zealand
United States
U.S.S.R.

---

* Births only.
+ Births and general mortality only.

[1] Angola is included in general mortality and infant mortality group only.
[2] Albania is not included in mortality lists.
[3] Mexico is in the "C" column for general mortality.
[4] Malaysia rated on basis of Peninsular Malaysia
[5] Sri Lanka is only included in the general mortality group.

3.5.4 Other Aspects of Data Quality

Other factors besides completeness affect the quality of vital statistics based on registration records. These include promptness of reporting, the reliability of reported data, compilation and publication procedures, whether data are tabulated according to date of birth or death as opposed to date of registration and by place of residence or place of occurrence, and the availability of appropriate population estimates required for the computation of crude and specific rates. Several of these factors are discussed below. For a more complete description of factors that affect the quality of registration data, see "Criteria for the Comparative Evaluation of Vital Statistics Methods" (Powell, 1975:11-40).

3.5.4.1 *Delayed Registration*

Information on the extent of delayed registration is available for only a very few countries, at least in internationally available literature. A few examples are presented in Table 3.7, which shows the proportions of births and deaths occurring in years before the year of registration in Costa Rica (births), South Korea (births and deaths) and Japan (deaths). In Costa Rica from 1951 to 1962 the proportion of births registered the same year they occurred hovered around 80 percent, then improved slightly in 1963 and 1964. With the exception of 1961, the percentage of births registered 6 or more years after they occurred remained constant at about 6 to 7 percent in the years for which data are available. (It should be noted that these registered births almost certainly do not represent all births that occurred in the country, since some births are not registered at all, especially those of infants who die before their birth has been registered.)

In South Korea during the period 1956-66, delayed registration was at a much higher level than in Costa Rica, with particularly large numbers of registered births representing persons born at least five years previously. In 1961, a special campaign was conducted to encourage registration of vital events not previously registered; in that year nearly half of all registered births and deaths represented events that occurred in 1956 or earlier. In the late 1950s and early 1960s, Table 3.7 also shows available data on the very small amount of delayed death registration in Japan from 1956 to 1964. Most of the delayed registrations represent deaths that occurred several years previously rather than only a year or so earlier. Thus, even in a developed nation with a good CR/VS system there can be small amounts of delayed registration.

The last column in Table 3.7 presents the mean number of years delay in registration. In calculating these means, a half year was added to the last category; that is, 6.5 years was used for the category "6+", which means that the events were treated as having occurred during the sixth year preceding the year of registration. This addition of only a half year undoubtedly yields a conservative estimate for each of these residual categories.

3.5.4.2 *Variations in Reporting Requirements*

An important influence on the functioning of CR/VS systems is the extent to which governments place requirements on individuals who must register a vital event. Table 3.8 lists four requirements for birth registration and three for death registration that countries sometimes mandate, and specifies the number of countries with each requirement. Many countries have never had fee requirements or have eliminated them in recent years, but 13 countries still require a cash payment for the registration of a birth or death. Twelve of these 13 are developing nations. Also, there are some countries where a registration fee is not required by law but may be required informally in practice, either to a government employee or a third party.

Among the 100 reporting countries, 62 require a physician's or midwife's certificate to register a birth, although in a few of these cases witnesses can be substituted (for example, if no physician or midwife is in the immediate locale). Witnesses are listed as a requirement for birth registration and death registration in 31 countries, although these are not always the same countries. In some of these cases, witnesses are required only in the absence of medical certification; however, other countries require witnesses in addition to medical certification. The requirement of medical certification of death, widespread in European and other developed nations, now exists in 47 of the 64 developing nations.

TABLE 3.7 Delayed Registration of Vital Events in Costa Rica, Korea, and Japan: Percentage of Births and Deaths Occurring in Years Before the Year of Registration and Mean Number of Years Delay in Registration

Country and Year of Registration	Time of Birth							Mean Delay in Registration (in years)
		Number of Years Before Registration Year						
	Same Year	1	2	3	4	5	6+	
Part A. Births								
Costa Rica								
1951	80.1	19.9	--	--	--	--	--	--
1952	79.5	13.1	7.4	--	--	--	--	--
1953	81.7	11.2	1.4	5.7	--	--	--	--
1954	78.4	11.8	1.6	0.9	7.2	--	--	--
1955	78.4	12.4	1.5	0.9	0.6	6.3	--	--
1956	77.5	13.0	1.7	0.9	0.6	0.5	5.8	0.62
1957	78.2	12.4	1.5	0.9	0.6	0.5	5.9	0.61
1958	77.5	12.4	1.5	0.8	0.6	0.5	6.7	0.66
1959	79.9	10.8	1.6	0.8	0.5	0.5	5.8	0.59
1960	80.0	8.4	1.7	1.0	0.7	0.6	7.7	0.71
1961	77.3	8.0	1.2	0.9	0.7	0.5	11.4	0.93
1962	82.2	7.0	1.0	0.8	0.8	0.8	7.5	0.67
1963	86.0	6.2	0.8	0.6	0.5	0.6	5.3	0.49
1964	86.7	4.2	0.7	0.5	0.4	0.4	7.1	0.57
South Korea								
1956	34.6	65.4	--	--	--	--	--	--
1957	41.0	59.0	--	--	--	--	--	--
1958	37.0	63.0	--	--	--	--	--	--
1959	40.9	19.4	9.4	4.5	25.9	--	--	--
1960	37.3	11.4	6.9	5.0	3.2	36.3	--	2.53
1961[a]	23.3	16.0	5.6	4.5	4.0	46.7	--	3.14
1962	38.3	18.7	9.0	6.4	5.1	22.7	--	2.01
1963	36.7	27.6	9.6	5.8	3.8	16.6	--	1.71
1964	67.0	13.7	5.7	3.1	2.0	8.5	--	0.89
1965	54.8	16.4	10.0	5.6	3.3	2.0	7.8	1.27
1966[b]	49.5	18.5	9.2	7.4	4.3	11.2	--	1.38

approximately one third of the registered births in South Korea were not registered until one to three years after the birth.

The pattern of death registration in South Korea in the period 1956-66 was that about two thirds to three quarters of the registered deaths represented events occurring in the same year as registration. About a tenth of the registered deaths were deaths that occurred in the previous year or two years. Another tenth (and much more in the year of the special campaign and the years immediately thereafter) were for deaths occurring five or more years before registration.

TABLE 3.7 (continued)

Part B. Deaths

South Korea								
1956	62.4	37.6	--	--	--	--	--	--
1957	69.6	30.4	--	--	--	--	--	--
1958	71.4	28.6	--	--	--	--	--	--
1959	75.2	11.4	4.9	2.6	6.1	--	--	--
1960	75.4	13.4	4.9	2.0	1.6	2.6	--	0.50
1961[a]	37.4	10.8	3.1	1.6	1.1	46.0	--	2.79
1962	58.6	11.1	6.2	3.1	2.6	18.4	--	1.44
1963	49.0	17.2	5.5	6.0	3.0	19.3	--	1.64
1964	82.0	5.4	1.6	1.0	1.2	8.8	--	0.65
1965	75.9	7.5	3.1	1.8	1.2	10.6	--	0.82
1966	76.2	8.1	2.2	1.6	1.1	11.8	--	0.87
Japan								
1956	99.6	0.4	--	--	--	--	--	--
1957	99.5	0.1	0.4	--	--	--	--	--
1958	99.6	0.1	0.0	0.3	--	--	--	--
1959	99.6	0.1	0.0	0.0	0.3	--	--	--
1960	99.6	0.1	0.0	0.0	0.0	0.3	--	--
1961	99.7	0.1	0.0	0.0	0.0	0.0	0.2	0.01
1962	99.7	0.0	0.0	0.0	0.0	0.0	0.3	0.01
1963	99.7	0.0	0.0	0.0	0.0	0.0	0.3	0.01
1964	99.8	0.0	0.0	0.0	0.0	0.0	0.2	0.01

Note: Dashes indicate that the data were not available by single years after that point. For example, in Costa Rica in 1951, the data on delayed registration were tabulated in only two categories: same year and 1 or more years. Thus, the last entry in that row shows the percentage of births registered 1 or more years after they occurred.

[a] In 1961, a campaign to encourage registration of vital events never reported was initiated but not continued in subsequent years. This accounts for the comparatively high percentage of events that occurred 5 or more years before registration.

[b] Up to September 1966 only.

Sources:
Costa Rica: Costa Rica, Direction General De Estadistica y Censos (1964: Table 8).
Korea: Choe (1967).
Japan: Shryock and Siegel (1973:394).

Only four countries, including one European country, require the physical presentation of the newborn child in order for a birth to be registered. (The time and place at which the newborn must be presented are not specified in the available data.)

Place of Registration Most countries, 79 among 99 reporting, require that birth or death be registered by place of occurrence, as indicated in Table 3.9. This

TABLE 3.8 Number of Reporting Countries with Specified Requirements for Registration of Live Births and Deaths, Classified by Region

		Registration Requirements[a]						
		Births				Deaths		
Region	Number of Countries Reporting	F	MC	W	P	F	MC	W
Africa	19	5	12[b]	9[b]	1	6	13	11
Asia (Except Japan and Israel)	17	1	10	4	0	1	11	5
Latin America	23	6	15	13	2	5	20	11
Oceania (Except Australia and New Zealand)	5	0	3	2	0	0	3	3
Subtotal	64	12	40	28	3	12	47	30
Europe	30	1	17	3	1	1	26	1
Other Developed	6	0	5	0	0	0	6	0
Total	100	13	62	31	4	13	79	31

Note: If the existence of a particular regulation was not known, it was coded as "no" and hence not counted in this table. Cases in which the regulations were "recommended" but not required were also coded as "no." Cases where the requirement is in force in selected places or circumstances (e.g., in urban areas or "in the absence of a physician") were coded "yes" and hence included in the table.

[a] Key to requirements:

F = Fee
MC = Medical certification
W = Witness(es)
P = Presentation of child to registrar

[b] Includes cases of either MC or W, and cases where requirement exists for selected situations, e.g., non-hospital births.

Source: Derived from provisional results of a study on civil registration/vital statistics national practices conducted in 1977 by the United Nations.

TABLE 3.9 Requirements for Registering Births and Deaths by Place of Occurrence or Place of Residence, Classified by Region

		Registration Requirements					
		Births			Deaths		
Region	Number of Countries Reporting	By Place of Occurrence	By Residence of Mother	Both[a]	By Place of Occurrence	By Residence of Deceased	Both[a]
Africa	19	14	1	4	14	1	4
Asia (Except Japan and Israel)	17	15	1	1	15	--	2
Latin America	23	21	1	1	21	1	1
Oceania (Except Australia and New Zealand)	5	4	1	--	4	1	--
Subtotal	64	54	4	6	54	3	7
Europe	29	21	4	4[b]	21	4	4[b]
Other Developed	6	4	2[c]	--	4[d]	2[c]	--
Total	99	79	10	10	79	9	11

[a] It is possible that there was some confusion about this category among those who provided the information to the U.N.; it may be that some of the countries listed as "both" collect both types of information on their registration forms but that both are not required.

[b] Includes two cases of "either."

[c] In one case: by place where family registration book is kept.

[d] In one case: by place of burial.

Source: Derived from provisional results of a study on civil registration/vital statistics national practices conducted in 1977 by the United Nations.

means that the person reporting the event must do so in the registration area where the event occurred, which may or may not be the legal residence of the person concerned--the mother in the case of a birth or the deceased in the case of death. For collecting national totals to calculate national rates, the place of registration does not matter, but it becomes an important factor in dealing with regional data. Whether the CR/VS system requires registration by place of occurrence or by residence can affect the data in two ways. First, it affects tabulation. Some countries do not have resources sufficient to tabulate CR/VS system data two ways; hence, if data are collected by place of occurrence, that is the way they are tabulated. Second, the completeness of data may be affected. For example, if the CR/VS system rules require registration by place of occurrence, those responsible for registering events may not bother to travel to the registration office in the place of occurrence once they have returned to their usual places of residence, thereby contributing to incomplete registration.

Ten nations require registration of a birth by residence of the mother, eight require registration by both residence and place of occurrence, and two permit either. For deaths, nine countries require registration by place of residence of the deceased, nine by both place of occurrence and residence of the deceased, and two nations allow either. It is possible that there was some confusion about the "both" category among persons who filled out the questionnaires for the U.N. study. It may be that some of the responses listed as "both" were meant to indicate that data of both types are collected on the registration forms but are not necessarily required. Nevertheless, it is clear that most nations require registration of births and deaths by place of occurrence.

Age of Mother If data from a CR/VS system are to be used to ascertain patterns of childbearing among different age groups, registered births must be classified by age of mother. An important corollary is that the estimation of levels of completeness of both birth and death registration is enhanced by having registered births and deaths classified by age groups (Hill et al., 1981). Several countries tabulate and publish this information, making the data available for international purposes. Table 3.10 lists developing countries for which birth data are classified by age of mother and available in the 1975 and 1978 U.N. Demographic Yearbooks (UNDY). The 1975 UNDY covers the years 1966-74; the 1978 UNDY reports "latest available year." A total of 76 developing countries are listed (including a few areas, e.g., Puerto Rico), and many of them have series covering several years. Thirty-eight of these countries are in Latin America and the Caribbean. In Asia only three developing countries with populations over 10 million have included 1970s information: Malaysia, Thailand and the Philippines. Countries tend to fall into two categories in terms of "latest available year" for this data. For 25 countries the latest available year is 1976 or 1977, which means a lag of two to three years between the occurrence of births and publication of the data in an international yearbook (given that the 1978 Demographic Yearbook was published in 1979). The second category includes countries with much longer time lags, in the neighborhood of 8 to 10 years. Table 3.10 also shows the few cases in which birth data are available by both mother's age and urban/rural residence.

Birth Order The estimation of fertility levels and trends is also enhanced by data on birth order. In addition, geographic breakdowns of available data into urban/rural classifications permit the estimation of regional variations. Table 3.10 lists (in the last column) the years for which birth-order data from CR/VS systems in developing nations are available in the 1975 UNDY. The availability of information on birth order tends to parallel the availability of data by age of mother, although birth-order data are available for slightly fewer countries.

3.6 ATTEMPTS AT IMPROVEMENT

For registration systems to be effective, the required processes for registration need to be understood by the population. Research is limited on how well populations understand what they are required to do, how they feel about these requirements, and what they report they have or have not done regarding registration. A special survey was conducted in Thailand in 1966, as a supplement to the first Survey of Population Change in that country. The purpose was to obtain information about knowledge of, attitudes toward, and practices concerning

TABLE 3.10 Completeness of Birth Registration and Years for Which Selected Data on Births Are Available, as Reported in U.N. Sources: Selected Countries in Developing Regions

		Birth Data Available			
		Age of Mother		Mother's Age and Urban/Rural Residence	Birth Order
Region, Country or Area	Completeness of Birth Registration (as reported in PVSR, 1 Jan. 1981	Years Available (as shown in UNDY 75)	Latest Year Available (as shown in UNDY 78)	Latest Year Available (as shown in UNDY 78)	Years Available (as shown in UNDY 75)
Africa					
Algeria	U		1965		
Egypt	C	1966-73	1975	1975	1966-73
Ghana	...	1971[a]	1971[a]		1971[a]
Libya	U	1972	1976		
Madagascar	U	1966-67,1971-72[a]	1972[a]		
Mauritius	C	1966-74[a]	1977[a]		1966-74[a]
Reunion	C	1966-70	1970		1970
Seychelles	C	1966-74	1976		1967,1969-74
Tunisia	C	1966-72	1974	1974	1969-72
Asia					
Brunei	C	1970-74	1976	1976	
Burma	U	1967[a]	1967[a]		1967[a]
Cyprus	...	1966-74	1977		1966-67,1971-74
Hong Kong	C	1969-74	1977		1969-74
India	...		1964[a]		

Jordan	C	1969-74	1977		1969-74
Kuwait	C	1966-70,1973	1977		1966-73
Macau	...	1966-70	1974		1966-70
Malaysia	U	1966-72,1973[a]	1976[a]		1966-73[a]
Philippines	U	1966-72,1974	1974		1966-71,1974
Singapore	C	1966-74	1977		1967-74
Sri Lanka	C	1966-69	1969		
Thailand	U	1966-73	1976		1966-73
Latin America					
Antigua	C	1973-74	1975		1974
Argentina	C	1966,1968-70	1970		
Bahamas	C	1968-74	1976		1968-70,1972, 1974
Barbados	C	1966-73	1975		1967-73
Belize	U	1966-71	1971		
Bermuda	C		1965		
Bolivia	U	1966	1966		
Chile	C	1966-71	1974		1966-71
Colombia	U	1966-69	1969		1966-68
Costa Rica	C	1966-74	1976		1966-72,1974
Cuba	C	1966-71	1971	1971	
Dominica	C	1966	1969		1966
Dominican Rep.	U	1966-73	1975	1974	1966-73
Ecuador	U	1966-73	1974		1966-73
El Salvador	C	1966-73	1976	1976	1966-73
Fr. Guiana	U	1966-70	1966,1970		1970
Grenada	C	1966-69	1969		1967-69
Guadeloupe	C	1966-70	1970		1970
Guatemala	C	1966-72	1973		1968-72
Guyana	C	1967-71	1972		1971
Honduras	U	1966-71	1976		
Jamaica	C		1964		
Martinique	C	1966-70	1970		1970
Mexico	U	1966-72	1974		1966-73

the registration of vital events as well as reasons for failure to register events. Arnold and Kuhner (1980:101) summarized the conclusions of the study:

> A major goal of the survey was to make use of the results for improvement of the registration system. The survey found that the legal regulations for registering births and deaths were generally quite well understood by the respondents. Over 90 percent correctly answered that events must be reported to the kamnan or at the municipality offices. The majority also knew whose responsibility it is to register events and approximately within what time period events should be registered. The majority also knew that no fee is charged for registration and that no documents have to be taken to the registrar. However, there was considerable misunderstanding of the correct procedure for registering events that occur outside the tambol (commune) of usual residence. Only 1/3 of the respondents knew that such events should be reported to the registration office where the event occurred. Failure to register events was evidently due to a lack of motivation on the part of the informant rather than to a lack of understanding or inconvenience in registering the event. It was also found that the registrars sometimes underestimated the necessity of recording all events within the specified period of time. The Supplementary Survey also showed that the maintenance of vital registration records was often rather low priority because registrars at all levels were usually overburdened with a variety of other tasks.

There are numerous actions that can be taken to improve the quality of CR/VS systems. The Conventional Vital Registration System (Powell, 1975:41-43) divides a number of possible improvements into two classes: (1) action needed on the national level, and (2) action needed at the international level. A document from the POPLAB Secretariat, Development of a National Strategy for the Improvement of Civil Registration and Vital Statistics (Laboratories for Population Statistics, 1976), gives a more detailed list of 24 possible actions classified into five categories:

(1) Assessment of problem and utilization of available resources
(2) General and interministerial activities
(3) Activities primarily the responsibility of civil registration authorities
(4) Activities primarily the responsibility of vital statistics authorities
(5) International activities

In considering feasible ways of improving CR/VS systems, government authorities and CR/VS experts recognize that some can be effective in a rather short time perspective, whereas others will achieve results only over a long time span. For example, actions that assume the urbanization of the population, that depend on increasing national literacy, that require education of the public regarding the obligations and benefits of registration, that rely on vastly improved transportation and communication facilities, or that assume substantial social and economic development of the nation certainly require a long-range time perspective. On the other hand, improvements that can be achieved by better coordination, increased administrative controls, revised and more timely tabulation programs, or by more intensive and systematic use of estimation and analytical methods, are all possible in a shorter time span. Allowing for exceptions, the evidence suggests a generalization that improvements in the compilation of vital statistics may be made on a short-term basis, while improvements in the civil registration system are more long-range.

3.6.1 Use of Indirect Estimation Methods

As indicated earlier, greater use of vital statistics data has become possible through the development of techniques that allow utilization of incomplete data and measurement of the quantitative deficiencies of data. There is a large scientific literature relating to methods for estimating underregistration of vital events and deriving estimates from defective data, for example: United Nations (1955:200-212), United Nations Manual IV (U.N., 1967), Brass (1975), and Indirect Techniques for Demographic Estimation (Hill et al., 1981). A description of these methods is outside the scope of this report, but the growing awareness, availability, and utilization of these indirect methods with incomplete vital registration data is leading to better estimates of fertility and mortality. (See Figure 2.7 in Chapter 2 for a list of some of these techniques.)

3.6.2 The Tabulation Area Approach

In many developing countries the registration system may be so defective that the tabulated results of the system as a whole cannot be used as a basis for estimating fertility and mortality rates. However, in many cases, even though the overall totals are defective, there are certain geographic areas of the country (such as some large cities, the more developed provinces, etc.) where the registration data are of an acceptable level of completeness and accuracy. Use of such data constitutes what is known as the "tabulation area" approach.

In practice, this means that at the tabulation stage the returns from all areas of the registration system are divided into two groups: (1) those that satisfy certain established criteria as to the quality of the civil registration records, and (2) those that fail to satisfy such criteria. The first group of areas constitute a "national vital statistics tabulation area," and data from this area form the primary basis for national tabulations and estimates of fertility and mortality. Data from the second group are given lower priority and less detailed treatment, and in some cases are not even tabulated. This concept is discussed in detail in the U.N. Handbook of Vital Statistics Methods (U.N., 1955:164-167). Because of the importance of this approach, the U.N. recommendations regarding it are quoted in full in Figure 3.1.

A disadvantage of the tabulation area approach is that it makes it more difficult to generate denominator data that correspond by area to the numerator. This is particularly troublesome if the tabulation area is regularly changing, as more areas of the country are included in the tabulation area. A further disadvantage of changing the area is that spurious trends can be introduced. Moreover, the practice of selecting certain areas to be tabulated according to some criteria of quality and then using the aggregated results as an approximation of national figures violates, of course,

FIGURE 3.1 U.N. Recommendations Concerning the Use of Tabulation Areas in Civil Registration/Vital Statistics Systems

---

1. Tabulation Areas

One of the basic premises of the vital-statistics system is that every vital event which occurs among the population of the geographic area should be first registered for legal purposes (Principle 203) and secondly, reported for statistical purposes (Principle 301). Ideally, therefore, the goal of tabulation coverage should be 100 per cent in respect of both geographic areas and population groups. Even in the most advanced societies, however, it is known that a small percentage of births and deaths may fail either to be registered or reported on time. Thus, for all practical purposes, the standard of tabulation coverage falls to a more realistic level, somewhat short of 100 per cent.

International recommendation

The United Nations recommendations on the matter of tabulation coverage have been set forth in Principles 402 and 403, both of which state the fundamental concept of complete geographic and ethnic coverage in tabulations. But these Principles, as will be seen below, also recognize the inevitability of less than perfect compliance, and the need for standards against which performance may be measured objectively.

402. Tabulation area--geographic aspect

(a) In accordance with individual national conditions and needs, specific standards for completeness of registration and data coverage should be set up, and every effort should be made to ensure that the data for the entire national territory meet these standards.

(b) Where it is impossible to secure figures for the entire national territory which meet the predetermined degree of completeness with respect to registration and data coverage, detailed tabulations should be made only for data from geographic areas which meet the specified conditions. Separate but regular tabulations should be made for data from areas falling below the determined criteria, and efforts should be made to improve registration in the sub-standard areas with a view to including them as soon as possible in the 'national tabulation area.'

(c) In such cases where the national tabulation area is less than the national territory, special care should be taken to explain limitations of coverage and the implications thereof wherever the statistics appear.

Source: United Nations (1955) Handbook of Vital Statistics Methods. Studies in Methods, Series F, No. 7, Sales No. 1955.XVII.1. New York: United Nations.

all the principles of probability sampling. However, if the areas or groups included are clearly defined, then the results are valid for that defined population.

In spite of the biases and problems just noted, the tabulation area method has been used successfully in a number of countries during the early stages of developing a nationwide registration system of adequate quality. In effect, no assumption is made about the vital rates being the same in the tabulation areas and nontabulation areas. Some of this experience is described in the U.N. handbook (U.N., 1955). Indonesia offers a recent example of this approach. During the 1970s special registration areas of about 30,000 population each were established to obtain information on how best to develop a national CR/VS system (Indonesia, 1979).

One major developing nation that used a modified version of the tabulation area approach for several years is Egypt. Until the early 1960s, Egypt classified the registration of births and deaths as occurring in health bureau areas (HBAs) or in non-health bureau areas. The initial registration of births and deaths in Egypt is linked to the health bureaus, which each serve the health needs of a population of 15,000 to 20,000. Areas with populations of this size and served by a health bureau within the area were designated HBAs, and those without health bureaus as non-HBAs. As the country established more health bureaus, the proportion of non-HBAs declined. During the years for which tabulations were made separately, major differences appeared in the levels of registration completeness in the HBAs and the non-HBAs. This tabulation area approach enabled the government to make more accurate estimates of vital rates in all of Egypt by using the estimates obtained from the HBAs as indicating levels closer to reality.

Perhaps the largest-scale application of the tabulation area concept was in the United States, where it was referred to as the "registration area" method. Early in this century the U.S. established certain criteria that would qualify a state to be admitted to the U.S. Registration Area. In general, these criteria specified that a state must (1) adopt registration legislation that corresponded to a model law drafted by federal authorities, (2) adopt a registration document corresponding more or less in form and content to the U.S. model certificate, and (3) achieve a registration completeness of 90 percent on the basis of federally conducted tests.

Using these criteria, the U.S. National Death Registration Area was established for data beginning with the calendar year 1900. The National Death Registration Area for 1900 consisted of 10 states, the District of Columbia, and a number of cities in other states. The area grew gradually as more and more states satisfied the criteria, until in 1933 it included the entire continental United States.

The U.S. National Birth Registration Area was not established until 1915. The original 1915 area consisted of 10 states and the District of Columbia. This area also grew gradually with admission of additional states until in 1933 it also included the entire continental U.S.

There is no way to demonstrate precisely how well the tabulated death rates for the growing Death Registration Area in the period 1900-33 and the birth rates for the growing Birth Registration Area from 1915 to 1933 corresponded with the rates for the complete U.S. At times after 1933, parallel tabulations were made for the total U.S. and for the original registration areas. Some biases were certainly evident for those post-1933 years, yet it is doubtful that the biases were of a magnitude that would have altered major U.S. policy decisions that had been based on the biased data (see Linder and Grove, 1943: Tables 2 and 45). Also, some of the indirect estimation techniques and general demographic methods permit estimation of birth and death rates for the indicated periods; these rates can be compared with rates generated by the Registration Areas.

3.6.3 The Sample Registration Approach

The general statistical technique called probability sampling is applied in various ways with different methods of collecting fertility and mortality data, however the term "sample registration" is used here with a narrow and precise meaning. It is restricted to the concept as defined in the U.N. Handbook (United Nations, 1955:167) and described in detail by Hauser (1954) in a paper presented to the 1953 International Conference of National Committees for Health and Vital Statistics. In his paper, Hauser presented a broad range of uses of sampling in civil registration and vital statistics and offered a detailed proposal for "a self-sufficient sample vital statistics system." The sample registration concept offers theoretical improvements over the tabulation concept, but it seems to have more intractable administrative difficulties.

Hauser envisioned a sample CR/VS system not only as a way to obtain useful data economically and quickly but as a first step toward the development of a complete national registration system. In proposing its establishment, he spelled out several principles (1954 and 1971:10):

1. The sampling unit should be complete primary registration units or combinations thereof.

2. The sampling method used must be administratively feasible with the resources available and should give assurance that the sample:

    (a) is representative of the entire universe for which vital statistics are desired;

    (b) provides a basis for the measurement of sampling error; and

    (c) minimizes the cost for any given level of sampling error or vice versa.

3. The sample should be large enough to provide vital statistics within agreed thresholds of sampling error for stipulated geographical areas of population subgroupings.

Hauser recognizes that a complete primary registration unit may not necessarily be the most effective sampling unit for the purpose of generating vital statistics. However, if the sample system is to be also an effective way of working toward the desired goal of a complete registration system, it must be tied tightly to the conventional civil system. In his words (1954 and 1971:11): "The sample system would be organized and staffed in the same manner as if a complete registration system were being established."

Perhaps the first, and possibly the only, experiment in applying the sample registration concept was that initiated in southern Peru in 1958 and reported by Cavanaugh (1963). The general plan of the Peruvian experiment was to select a representative sample of existing registration units, which were defined as administrative political entities; to improve registration of births and deaths in those sample units by a program of more intensive supervision and training of the regularly designated local registration officials; and to inflate the sample estimates to obtain estimates for the larger geographic universe from which the sample units were drawn. The universe area had a population of 2.4 million.

The Peruvian experiment was a pioneering project that helped identify operational and policy problems in attempting to improve vital registration. However, the project was designed to proceed with very limited resources, and the field work lasted only a year because of these financial limitations. Since the project was located administratively within an ongoing health program, overhead costs were at a minimum. Even so, the project funds could support only the project director, a supervisor, and two field workers. The task of the field workers was to improve the quality of registration in 110 sample areas (out of 372 registration districts) by developing coordination among public health, school, and ecclesiastical authorities; instructing the local registrars in correct registration methods; educating the public about the value of civil registration and in other ways decrease the number of registration omissions.

It is unfortunate that more attention has not been given to the sample registration method of developing national vital statistics estimates and gradually improving the whole registration system. The key point in this approach is that the sampling unit must be a complete primary registration unit. This enables the sampling activities to be used to improve the functioning of the registration unit; as progress is made, the sample can be extended to include ultimately all the registration units in the country. Many technical and administrative problems accompany the use of sample registration areas, but the approach deserves more theoretical exploration and field trials in nations with different organizational patterns.

A modified version of the sample registration concept is used in India to obtain annual estimates of vital rates. The Indian method is called a Sample Registration System (SRS), but it does not fit the above definition; rather it is a dual-record system (described in chapter 4) that uses both survey and registration methods. When the system was instituted in 1965, it covered only certain rural areas. It was subsequently expanded and during the 1970s produced estimates of birth and death rates by state and by urban/rural breakdowns. In 1972, the SRS had a sample size of approximately 5 million persons. Administration of the SRS varies among states.

In estimates based on the Indian SRS, birth rates for small villages appear to be higher than rates obtained for large villages. One suggested reason is that since the SRS covers the entire village when it is small and only a section of it when it is big, the effects of an expanding population (such as households splitting, enlargement of inhabited areas, etc.) are present in the data collected for small villages, where the SRS areal unit expands as the village expands, but are partially or completely absent from the data obtained from bigger villages, where SRS coverage is restricted to only part of the village.

3.6.4 Coordination

As indicated above, in many countries the registration of vital events and their processing into statistics is the responsibility of a fragmented system--fragmented between national and provincial responsibilities and, at the national level, fragmented between two or more ministries. The absence of a single agency that is responsible for all aspects of the system--from the local registration process to the systematic collection of registration documents through the apropriate chain of local, municipal, and provincial authorities to a national agency with responsibility for the legal uses of the documents--is a major cause of many of the defects of existing CR/VS systems. Furthermore, although in some countries the translation of the documents into statistics can be accomplished by a separate organization or ministry, in other countries the division of collection and tabulation responsibilities among two major organizations may lead to coordination problems and delays.

In most instances it is not feasible to contemplate the drastic legal restructuring that would create a completely unitary system. However, there is evidence that considerable progress can be made by creating mechanisms that help coordinate the scattered units of the system. In some federal systems such as the U.S., Canada, and India, associations of provincial registration officials have been notably successful in creating procedures that are standardized for the whole nation.

More than 30 years ago, the WHO Assembly formally recommended that countries establish national committees for health and vital statistics. Many countries have established such committees, and WHO maintains a Secretariat unit that disseminates information on the activities of the committees. Two international conferences of representatives of these national committees, one in London in 1954 and one in Copenhagen in 1973, were very well attended and provided a forum for considering how the work of the committees could be carried forward most effectively.

Some of the national committees have operated on a continuing basis; others have fluctuated between periods of activity and periods of dormancy. While useful to some extent in improving civil registration and vital statistics, the committees have two major flaws that limit their potential impact on registration. Since the international recommendation was issued by WHO, the response naturally came from national health ministries. Unfortunately, national health ministries usually have only a minor or peripheral responsibility for registration; in most cases, they are not the agencies with effective coordinating influence on the problem of improving registration systems. In addition, the committees' primary frame of reference is health statistics, which means they are concerned primarily with the wide array of health statistics other than those that arise from the civil registration system. Nevertheless, in many countries the effectiveness of the vital statistics system depends on cooperative effort among several disparate agencies, and some mechanisms for coordination are essential.

3.6.5 Logistical Improvements

A civil registration system often comprises an extensive network of administrative units, extending from the national capital out to thousands of local registration units. The continuous operation of this system implies a flow of forms, materials, and instructions from the center, and a constant reverse flow of completed registration forms to the places where they are permanently filed and to the statistical office for tabulation. The logistical problems of supporting this

TABLE 3.10 (continued)

		Birth Data Available			
		Age of Mother		Mother's Age and Urban/Rural Residence	Birth Order
Region, Country or Area	Completeness of Birth Registration (as reported in PVSR, 1 Jan. 1981	Years Available (as shown in UNDY 75)	Latest Year Available (as shown in UNDY 78)	Latest Years Available (as shown in UNDY 78)	Years Available (as shown in UNDY 75)
Neth. Antilles	U	1966-73	1973		
Nicaragua	U		1967		
Panama	C	1966-73	1975	1975	1966-73
Paraguay	U		1960[a]		
Peru	U	1967-69	1972		1969
Puerto Rico	C	1966-73	1977		1966-67,1969-70, 1972-73
St. Kitts	C	1966-72,1974[a]	1976[a]		1966-72,1974[a]
St. Lucia	C		1963		
St. Pierre and Miguelen	C	1967,1969	1969		1969
St. Vincent	C		1964		1969
Trinidad and Tobago	C	1966-72	1976		1966-68,1970, 1972
U.S. Virgin Is.	C	1966-67,1969-73	1973		1966-1973
Uruguay	C	1967-73	1976		
Venezuela	U	1966-74	1975		1966-68,1971, 1974

Oceania					
American Samoa	C	1966-73	1976		1966-69,1971-73
Christmas Is.	C	1966-72			1966-72
Cocos Islands	C	1969-74			1969-72,1974
Cook Islands	C	1971-73	1973		
Fiji	C	1966-74	1976		1966-74
Fr. Polynesia	...	1968	1968		
Guam	C	1966-74	1977	1977	1966-68,1972-74
Nauru	C	1966-68	1968		1967-68
New Caledonia	...	1966-68,1970-74	1977		
Norfolk Is.	C	1966-74			1967-68,1970-72
Niue	...		1970		
Pacific Is.	U	1966-74	1976	1976	1966-74
Samoa	U	1967-74	1976	1976	
Solomon Is.	...	1969	1969		1969
Tokelau Is.	...	1971-72			
Wallis and Futuna Is.	...	1969	1969		

Note: Data reported for the following countries and years were derived from estimates based on sample surveys rather than civil registration:
Africa: Benin, 1961; Cameroon, 1964-65; Central African Republic, 1964-65; Chad, 1963-64; Congo, 1960-61; Gabon, 1960-61; Liberia, 1970-71; Malawi, 1971-72; Togo, 1961.
Asia: Indonesia, 1964; Pakistan, 1968; Turkey, 1967.

Data reported for the following countries and years are for ethnic subpopulations not representative of the country as a whole:
Africa: Namibia, 1963; South Africa, 1971; Zambia, 1968; Zimbabwe, 1976.
Oceania: Papua-New Guinea, 1971.

[a] Data reported are for selected areas of the country only and thus may not be representative of the country as a whole.

system are considerable and steps being taken to improve deficient systems include improved supervision of the routine operational aspects of the system and the establishment of controls and check lists on the flow of materials and documents.

3.6.6 Personnel Improvements

Several countries have tried to upgrade their registration systems by improving the quality and performance of the personnel responsible for operating each part of the system. Training materials have been developed, training seminars organized, regional and national conferences for registration officers held, and in a few cases model offices have been established where procedures are demonstrated and training is conducted. However, such efforts are not widespread nor are they usually continuous. In some cases, special efforts to improve the registration system are carried out for a few months, but then not continued.

Although mandating the registration of vital events and establishing a registration system have not proved difficult, in many countries it has proved difficult to make more fundamental administrative changes that could improve the registration system. Some of these more fundamental changes include increased salaries or reclassification of positions involved throughout the chain of operation, new budgetary allocations, and administrative redefinitions of the registration function in relation to other responsibilities that registration officials may have.

3.6.7 Public Education

Countries have also established programs of public education, so that those responsible for reporting vital events to the local officials are aware of their responsibilities and also aware of the benefits and rights that the registration of a vital event can ensure for them. Probably more education of the public would help to improve compliance with registration systems, especially if carried out concurrently with training programs for registration officials.

3.6.8 Improvements in Tabulation

Many improvements have been made at the statistical tabulation end of the CR/VS process. It is possible to make these improvements rapidly and at the discretion and control of a central office. Among others, these improvements have included: (1) improving supervision and control of tabulation; (2) remodeling tabulation programs to bring them into accord with international recommendations; (3) modifying schedules and procedures to improve timeliness of tabulation and publication, perhaps even skipping alternate years altogether to make the current tabulation schedule coincide with census dates; and (4) tabulating vital events on a sample basis. Some countries have adopted the pragmatic principle that while 100 percent registration should always be the goal, vital statistics tabulations can be prepared using samples that include many fewer cases than tabulation on a 100 percent basis.

Because of delayed registration, it is good to update initial tabulations each year, perhaps with a cut-off after five years. After that point, the revised tabulations are likely to include most events whose registration was delayed.

3.7 SUMMARY

In evaluating the CR/VS system as a general source of data for computing fertility and mortality levels and trends, the Panel emphasizes that the quality of the systems among the countries of the world varies from excellent to very poor. In many countries the system is almost perfect, while in others it is rudimentary. For some of the latter countries the basic problems arise in the actual reporting of the event at the local level; for others the main problems are central, such as a lack of coordination among agencies or deficiencies in the tabulation process or the failure to collect systematically information that is in fact recorded in the field.

All the developed countries and a number of developing countries have fully adequate systems, as indicated in Table 3.5 and the related discussion in this chapter. Many of the 92 countries whose birth registration data are classified "complete" in 1981 are developed countries; others are small special cases such as Hong

Kong and Singapore. However, also included among the 92 are Egypt, Tunisia, Costa Rica, El Salvador, Panama, Chile, Uruguay, Peninsular Malaysia, and other developing nations. Thus, even some countries usually considered to be in the developing category have CR/VS systems that may provide adequate information on levels of fertility and mortality, and for a few the level of accuracy is sufficient to ascertain trends. Many other countries are on the brink of having their registration systems become adequate for analytical purposes, particularly if they are able to utilize direct and indirect techniques for estimating levels of incompleteness of the registered events. These techniques have recently been applied to data in Korea, Bangladesh, Thailand, India, Egypt, Turkey, Brazil, Colombia, and other countries. For information on these applications, see the series of country reports produced by the Committee on Population and Demography (those published in 1980 and 1981 are listed on the inside back cover) and the Committee's manual on indirect estimation (Hill et al., 1982). Other applications are reported in the standard demographic literature.

The CR/VS system has a firm legal structure. It provides "flow" data on an annual basis and it can accommodate a sufficient number of variables to make possible estimation of basic fertility and mortality levels and trends. Moreover, it is the only data collection system that usually returns some benefit (a useful legal document) to the individual respondent or a close relative. In addition to providing data for the estimation of national and regional fertility and mortality, properly functioning CR/VS systems permit the analysis of such detail as trends in deaths by age among infants (how many in the first day, the first week, the first month, etc.), as well as by place of occurrence or place of residence.

The benefits and sanctions associated with CR/VS systems have important bearing on why these systems function at different levels of completeness. The population has to receive and perceive the benefits associated with the registration of vital events. Likewise, a government must be willing and able to enforce legal sanctions regarding registration. These factors are all affected by cultural patterns and by levels of development.

For the analytical use of CR/VS data to produce valid estimates of fertility and mortality, coverage completeness of 60 percent or more is usually necessary, although in some situations estimates are possible even if coverage is less than 60 percent. The level of registration completeness can be measured by using other CR/VS data to make internal checks on the levels of underregistration. In the case of births, this internal check can be performed by analyzing birth order by age; in the case of deaths, by analyzing deaths by age. Checks can also be carried out using information obtained from other data sources, including sample surveys.

The importance and basic soundness of the CR/VS system was underlined in the 1974 U.N. World Plan of Action (United Nations, 1974), which urged countries to improve their CR/VS systems and recommended the use of alternate systems "until this improvement is completed," thus implying that alternate systems are necessary as a interim measure. As noted earlier, the improvement of CR/VS systems in countries where they are now inadequate requires a long-range perspective in many cases; it is essential to lay the foundations of reliable CR/VS systems to produce analyzable data in the future. Programs to improve coverage, completeness, and quality in CR/VS systems merit careful consideration and action.

REFERENCES

Arnold, F., and A. Kuhner (1980) "Analysis of Vital Statistics Services in Thailand." Chap. 4 in Vital Registration Systems in Five Developing Countries: Honduras, Mexico, Philippines, Thailand, and Jamaica. Vital and Health Statistics Evaluation and Methods Research, Series 2, No. 79. Washington, D.C.: National Center for Health Statistics.

Brass, W. (1975) Methods for Estimating Fertility and Mortality from Limited and Defective Data. Chapel Hill, N.C.: Laboratories for Population Statistics, University of North Carolina.

Cavanaugh, J. S. (1963) Sample vital registration experiment. In Proceedings of the International Population Conference Vol. 2, pp. 363-371. London: International Union for the Scientific Study of Population.

Choe, E. H. (1967) Problems and Adequacy of Vital Statistics in Korea. Publication Series No. 1, Population Studies Center. Seoul: Seoul National University.

Costa Rica, Republica de, Direccion General de Estadistica y Censos (no date) Estadistica Vital: 1964, No. 29. San Jose: Direccion General de Estadistica y Censos.

Hauser, P. M. (1954) The use of sampling for vital registration and vital statistics. Bulletin of the World Health Organization 11(1-2). Reprinted 1971. Chapel Hill: University of North Carolina: International Program of Laboratories for Population Statistics Reprint Series No. 2, pp. 5-23.

Hill, K., H. Zlotnik, and T. J. Trussell (1981) Indirect Techniques for Demographic Estimation. Committee on Population and Demography, Assembly of Behavioral and Social Sciences, National Research Council, National Academy of Sciences. (To be published as Manual X in the series of manuals of demographic analysis of the Population Division, United Nations.)

Indonesia, Sample Vital Registration Technical Team (1979) Analysis and Evaluation of the Sample Vital Registration Project, 1974-1977. Technical Report Series, Monograph No. 6. Jakarta: Biro Pusat Statistik (Central Bureau of Statistics).

Japan, Ministry of Health and Welfare (1967) Number of Births and Deaths by Years of Occurrence and Years of Registration for All Japan: 1900-1964. Research Series No. 182, December 1967. Tokyo: Ministry of Health and Welfare. (Table 2. Also shown in Shryock and Siegel, 1973:Table 14.)

Laboratories for Population Statistics (1976) Development of a National Strategy for the Improvement of Civil Registration and Vital Statistics. Conference document 61 PC. Chapel Hill, N.C.: University of North Carolina.

Linder, F. E. (1969) Methods for Measuring Population: A Systems Analysis Summary. Public Health Service Publication 1000, Series 2, Vital and Health Statistics No. 43. U.S. Public Health Service, National Center for Health Statistics. Washington, D.C.: U.S. Government Printing Office.

Linder, F. E., and R. D. Grove (1943) Vital Statistics Rates in the United States, 1900-1940. Washington, D.C.: U.S. Bureau of the Census.

Linder, F. E., and J. W. Lingner (1975) Systems of Demographic Measurement, General Evaluation: The Measurement Problem. Scientific Report Series No. 22, International Program of Laboratories for Population

Statistics. Chapel Hill, N.C.: University of North Carolina.

Madigan, F. C., and A. N. Herrin (1977) New Approaches to the Measurement of Vital Rates in Developing Countries. Reprint Series No. 18, International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

National Research Council (1981) Estimation of Recent Trends in Fertility and Mortality in Egypt. Panel on Egypt, Committee on Population and Demography. Washington, D.C.: National Academy Press.

Powell, N. P. (1975) Systems of Demographic Measurement, Data Collection Systems: The Conventional Vital Registration System. Scientific Report Series No. 20, International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Powell, N. P. (1977) Organizational Arrangements for a Vital Registration System. Working Papers, No. 1, International Institute for Vital Registration and Statistics. Chapel Hill, N.C.: University of North Carolina.

Preston, S., and K. Hill (1980) Estimating the completeness ofdeath registration. Population Studies 34(2):349-366.

Preston, S., A. J. Coale, T. J. Trussell, and M. Weinstein (1980) Estimating the completeness of reporting of adult deaths in populations that are approximately stable. Population Index 46(2):179-202.

United Nations (1953) Principles for a Vital Statistics System: Recommendations for the Improvement and Standardization of Vital Statistics. Statistical Papers, Series M, No. 19(ST/STAT/SER.M/19), Sales No. 1953.XVII.8. New York: United Nations.

United Nations (1955) Handbook of Vital Statistics Methods. Studies in Methods, Series F, No. 7 (ST/STAT/SER.F/7), Sales No. 1955.XVII.1. New York: United Nations.

United Nations (1958) Handbook of Population Census Methods. Studies in Methods, Series F, No. 5, Rev. /(ST/STAT/SER.F/5/Rev. 1), Sales No. 1958.XVII.6 (Vol. 1). New York: United Nations.

United Nations (1962) Methodology and Evaluation of Continuous Population Registers. U.N. Statistical Commission, 12th Session, Doc. E/CN.3/293. New York: United Nations.

United Nations (1973) Principles and Recommendations for a Vital Statistics System. Statistical Papers, Series M, No. 19, Rev. 1. Sales No. E.73.XVII.9. New York: United Nations.

United Nations (1974) World Plan of Action. World Population Conference, Doc. E/Conf.60/WG/L.55/Add3. New York: United Nations.

United Nations (various years) Demographic Yearbook.ST/ESA/STAT/SER.R/. New York: United Nations. (Published annually.)

United Nations (various years) Population and Vital Statistics Report. Statistical Papers, Series A (ST/ESA/STAT/SER.A/). New York: United Nations. (Published quarterly.)

United Nations, Department of Economic and Social Affairs (1967) Methods of Estimating Basic Demographic Measures from Incomplete Data. Population Studies, No. 42, Manual IV (ST/SOA/SER.A/42). New York: United Nations.

United Nations, Statistical Office (1969) Methodology and Evaluation of Population Registers and Similar Systems. Studies in Methods, Series F, No. 15. Sales No. E.69.XVII.15. New York: United Nations.

4 Surveys

4.1 INTRODUCTION

Sample surveys using household interviews are a third method widely used to measure demographic phenomena. Surveys are used both to supplement data provided by censuses and civil registration and to substitute for such data when census and civil registration data are absent or deficient in content or quality. Covering only a sample of a population allows the flexibility to collect more detailed data than is possible in a census or civil registration, but it also introduces an additional source of uncertainty: namely, sampling error. More intensive training and supervision of field personnel are possible for surveys because the number of respondents is much smaller than in censuses or civil registration, but there is an additional requirement for carefully controlled field procedures to insure correct identification of sample units in the field.

A large number of surveys of varying types have been conducted to measure fertility and mortality. For example, an inventory by the World Fertility Survey (WFS) showed that 175 large-scale surveys were conducted in less developed countries (Baum et al., 1974a-d) from 1960 to 1973, and the WFS program itself includes national sample surveys in about 45 countries. This chapter reviews the experiences, problems, and contributions of surveys to the estimation of levels and trends of fertility and mortality. In addition to sections on background and definitions, the chapter includes a discussion of advantages and disadvantages of surveys and a checklist of major choices and decisions facing planners designing demographic surveys. It also presents information on surveys undertaken in developing countries to estimate the levels and trends of fertility and mortality and a summary.

A primary emphasis in this chapter is discussion of optimal procedures for collecting data on demographic change. Inevitably, the quality of data collected in a survey is directly affected by the sample design, the organizational arrangements, and the operational control of the survey. To keep non-sampling errors at acceptable levels, it is essential to use sound design principles and to apply good control practices in executing the design. Good survey design and execution are possible if sufficient resources, trained people, and adequate facilities exist. When they do not (which is the usual situation), trade-offs and compromises must be made between the ideal and the attainable to achieve a reasonably efficient design and execution to the extent that judicious allocation of resources permits.

The purposes of the sections that follow are to describe the state of the art in the design and execution of surveys to estimate fertility and mortality and to point out problems, aspects of surveys that require special attention, and the strengths and weaknesses of surveys as sources of data for demographic estimation. The issues discussed apply to samples built in to censuses and post-enumeration surveys as well as to sample surveys conducted independently.

Some surveys have produced good data; others have produced poor data, due to faulty design, poor execution, or both. In other cases, surveys have failed to produce valid estimates because of faulty data analysis. In particular, the traditional demographic surveys that use single-round retrospective questioning have generally produced data inadequate for fertility and mortality estimation, although the quality of the results from such surveys frequently can be improved by using indirect estimation and standard demographic techniques to adjust faulty data. Often survey data are accepted at face value without necessary corrections, leading in some cases to underestimates or overestimates of fertility and mortality. As emphasized earlier in discussing the complementarity of data collection sources, surveys can provide timely and rich data for fertility and mortality measurement, but they should not be looked upon as the only useful source.

This chapter is not intended to be a manual on how to design surveys of fertility and mortality, but it is more detailed than the chapters on the population census and

CR/VS system. This extra attention to details is necessary because there are so many more options to consider in the design of surveys, especially those whose primary aim is to collect information for estimating fertility and/or mortality. Because each step in the design and implementation of surveys is so important, there are separate discussions of general design considerations, sample design, coverage errors and biases, response errors and biases, and the precision of the estimates obtained. Another special feature in this chapter is the presentation of a checklist (Figure 4.1) that administrators may find helpful in planning, budgeting for, organizing, and monitoring a survey.

4.2 BACKGROUND

Attempting to design a survey that is judged to be the best that is feasible under a given set of resource constraints and political, administrative, and field conditions has been the practice of good survey statisticians for many years. General principles of household survey design and sample design procedures are relatively well known, and survey researchers have learned a great deal about how to maintain statistical and operational control over the data collection process in the field, which is a major difficulty in conducting any survey. Beyond these general concerns are the special data needs of surveys for estimating fertility and mortality. Certain design features may be more appropriate for demographic surveys than for other types of surveys. For example, demographic studies are often best served by samples that involve repeated interviews and exhaustive coverage of each sample area. Also, certain data, such as age, assume added importance in demographic surveys.

The inherent problems of obtaining useful data may or may not (depending on the circumstances) be compounded when demographic data are collected as a by-product in household surveys designed primarily for other purposes, such as measuring labor force participation or household expenditures. The special danger in that situation is that inadequate attention and time may be given to planning and collecting the demographic data, although that can also happen in surveys designed primarily to collect fertility and mortality data. Moreover, in surveys not focused primarily on collecting fertility and mortality data, the knowledge, experience, and priorities of the survey designers or administrators may not be those required for achieving adequate measurement of those data.

As indicated in Chapter 1, measuring even the clearest concepts--for example, age or children ever born--is not easy, and errors of varying magnitudes exist in virtually all data. Demographic survey planners, along with designers of censuses and civil registration and vital statistics (CR/VS) systems, have learned that better results are obtained if they try to insure first that the esssential concepts are clearly defined and, second, that questions related to the concepts are made clear to respondents during their interviews.

It is often difficult to communicate demographic concepts to survey respondents in such a way that they are both able and willing to respond. Difficulties may arise because the interviewer is unable to make the concepts clear to respondents (for example, to explain who is or is not considered a household resident for the purposes of the survey) or because the interviewer's introductory comments and general attitude fail to make respondents willing to answer questions. Also, respondents may have cultural constraints or inhibitions regarding certain topics. However, even if these problems can be overcome, there remains the problem of respondents' lack of knowledge about current or past events or characteristics--for example, not knowing exactly how old they are or exactly when a birth or death occurred.

In the past, the statistical literature on surveys has been dominated by sampling designs aimed at minimizing sampling errors rather than designs aimed at controlling nonsampling errors and biases. However, more attention is now being given to optimizing designs with respect to total error. As Cochran points out (1977:396). "The study of these [nonsampling] problems is slow and difficult. Nevertheless a good beginning has been made."

Statisticians and demographers increasingly recognize and emphasize the importance of practicability in survey design (O'Muircheartaigh, 1977; Verma, 1977; Kish, 1977, and Scott, 1980). Still, there remains a wide gap between survey theory and practice. For example, in 1975 the American Statistical Association subsection on survey research methods initiated a study of survey practices in the United States (Bailar and Lanphier, 1978). In a small purposive sample to develop methodology, 36 surveys were reviewed for the type of design, the use of probability samples, and whether an evaluation was made of the resulting estimates. Of the 36 surveys studied in the review, 22 were judged to have failed relative to one or more of these criteria.

There are a number of books and manuals that describe the steps for planning and conducting demographic measurement surveys. These include Warwick and Lininger (1975), a handbook on vital statistics measurement by Marks et al. (1974), Scott and Blacker's manual for surveys in Africa (UNECA, 1974), and a series of manuals on different aspects of survey design and control published by the International Program of Laboratories for Population Statistics (POPLAB), including: Cooke, 1971; Simmons, 1972; Sirken, 1972; Scott and Chanlett, 1973; Booth and Lingner, 1975; and POPLAB, 1978. A series of manuals by a francophone working group on African demography describes the experience of single-round surveys carried out in tropical Africa during the 1960s (INSEE-INED 1967), multi-round surveys (ORSTOM-INSEE-INED 1971), and problems associated with the collection, adjustments, and analysis of demographic data in Africa (INED-INSEE-ORSTOM-SEAE 1973, 1974, 1975 and 1976). Other French-language works include books by the Department of Demography of the Catholic University of Louvain (1976) and by Tabutin (1976). The World Fertility Survey (WFS 1975, 1976, and 1977) Basic Documentation series includes core questionnaires, together with manuals on all elements of survey design and analysis of the WFS surveys; much of this material is directly applicable to other demographic surveys. Good references on general sample design include Hansen et al. (1953), Cochran (1977), and Kish (1965). The U.S. Census Bureau Popstan series (1979), which covers all aspects of planning a multi-subject, continuing household survey program, includes special modules on demographic surveys. The Statistical Papers and other series of the United Nations also include reports specifically concerned with demographic sample surveys (e.g., U.N., 1970a and 1971) and household surveys in general (e.g., U.N., 1964; 1970b; 1972).

4.3 DEFINITIONS

Four general types of surveys have been used to collect data on fertility and mortality in developing nations:

single-round demographic surveys, multi-round surveys, dual-record systems, and fertility surveys. The many possible variations in the design features of the four types create some confusion in distinguishing among them. In an effort to minimize confusion, we define the first three types of surveys mainly in terms of the number of interviews and type of interviews used with the units in the sample. The defining characteristic of the fourth type, the fertility survey, is that it includes a fertility or pregnancy history; aside from this, it is normally a single-round survey.

To discuss the four types of surveys requires the definition of some common terms:

- A *round* is a complete set of single interviews with each unit in the sample, whether households or persons.
- The *reference period* in surveys and dual-record systems is that period of time for which vital rates or other demographic variables are to be estimated (for example, child mortality "in 1960-65").
- The *recall period* is the period for which respondents are asked to recall and report demographic events of interest (for example, births "in the past 12 months" or children "ever" born). A recall period may be *bounded* at one or both end points by the dates of events or by the interview(s) or it may be *unbounded* at the end further back in time. In the case of fertility surveys, the recall period is the number of years for which pregnancy information is obtained, for example, the last five years (bounded at both ends) or the entire pregnancy history (unbounded at the far end).

In a single-round survey the recall period must be at least as long as the reference period. In some multi-round surveys the recall period for one interview can partially or completely overlap recall periods used at previous interviews. Often the recall period and the reference period will coincide. However, in surveys that have overlapping recall periods or in dual-record systems in which the two recording systems cover the same time period, it is essential to distinguish carefully between reference periods, recall periods, and time intervals between rounds.

In its most general sense, a multi-round survey is one in which the same sampling units are followed and interviewed more than once. Other terms commonly used to refer to multi-round surveys are "panel" and "longitudinal" or "follow-up" survey, each of which has a usual definition and implies certain attributes. A panel usually refers to the practice of following a particular group of individuals, rather than households, over time. A follow-up survey usually implies interest in particular changes (e.g., household composition) or events (e.g., births and deaths). In the usual multi-round survey, all persons residing in the sample area at the time of each visit are covered.

Multi-round follow-up surveys to collect data on vital events may also be referred to as prospective surveys. They are prospective in the sense that the first round is used to establish a set of "baseline" information, then subsequent rounds investigate the vital events that occur after the first round (which clearly fixes the reference period and makes the recall period bounded at both ends). In operational terms, an interviewer may inquire in two ways about events that occurred prior to a follow-up visit: (1) by asking about the current status of household members, e.g., "Is X alive?" or "Is Y pregnant?"; and (2) by asking about changes or events that occurred before the follow-up visit, e.g., "Was anyone born or did anyone move into this household in the past N months?", "Was there any death in this household in the past N months?". The first type of question is considered prospective because it is based on prior information about the existence of X and Y; the second type of question is retrospective.

4.3.1 Single-Round Demographic Surveys

If each respondent is interviewed only once (except for possible followup visits to clarify certain responses) and retrospective questions on vital events are asked (but a fertility or pregnancy history is not collected), this is generally called a single-round retrospective survey. Occasionally such a survey is repeated in an entirely independent sample; to avoid confusing this approach with a multi-round survey, we refer to it as a "repeated single-round survey." Similarly, survey systems in which different (multiple) subjects are covered at different times will be referred to as a single-round demographic survey if only one round is devoted to covering vital events. A set of reinterviews done within a short time after the survey exclusively for the purpose of evaluating the quality of data or for checking on the interviewers ordinarily are considered part of the same round. Reinterviews for such purposes usually are done only in a comparatively small subsample; if they are conducted in the whole sample, the distinction between single and multiple rounds becomes less clear.

4.3.2 Multi-Round Surveys

A multi-round survey includes at least two rounds of interviews at each sample unit, separated by a given period of time. The composition and other characteristics of the household are recorded at the initial interview; changes in household composition and information on births and deaths after the initial visit are obtained in one or more follow-up visits. Retrospective data on vital events (e.g., children ever born or complete fertility histories of individual women) may also be collected in the initial baseline survey. The initial interview of a multi-round survey may be identical to a single-round interview except that sufficient information must be recorded to enable interviewers to locate the household or individual for one or more future visits.

In multi-round surveys, special questions and interviewer attention are needed to obtain information on babies who are born and die in the period between consecutive rounds and to obtain information on new persons who join the household. Also, it is important to update the sample at each round rather than to follow a "fixed" panel, which will suffer attrition as people move out of the sample area between rounds. The recommended approach is to use area sampling, in which all households in the sample areas are covered in each round, including all new households. In multi-round surveys that use area sampling, people who move out of the area between rounds are not included in subsequent rounds. Because the unit to be interviewed is a residential address, a new face sheet for the questionnaire, which tells who is currently living at the address, must be completed in each round.

A number of options are possible for follow-up visits; some have proved less desirable than others. One important distinction is whether interviewers at the follow-up interviews use the information recorded in earlier visits. If interviewers do not have information from previous rounds, an entirely new schedule, listing all persons present in the household and accounting for vital events that have occurred since the previous visit, is prepared at each round. Information thus collected can be utilized without reference to that from previous rounds. This approach is not very different from conducting independent, repeated single-round surveys; indeed it is generally more complicated than a single-round survey because of the difficulty of insuring that all interview units from previous rounds are included or accounted for in the subsequent round. As a result, it is not frequently used.

To gain the most from multi-round surveys, some use usually is made of the information from previous rounds. Data collected in the new questionnaire or schedule are reconciled with those from previous schedules, either in the office or, preferably, in the household immediately following completion of the new schedule. Alternatively, a further follow-up visit is made specifically to reconcile discrepancies between data collected in different rounds (Sabagh and Scott, 1973).

Using a schedule that contains information about persons present at previous visits provides the interviewer with a basis for updating information about the household and detecting vital events that have occurred in the intervening period. This "household change" method is the most direct approach and has the advantage that the interviewer can resolve differences in the household without a reconciliation visit. It is also the most commonly used. It does require very careful supervision, because interviewers may be tempted to simply report "no change" rather than visiting the household and conducting a follow-up interview or be tempted to accept a respondent's first reply that there has been "no change" without probing further.

The household change method also eliminates or reduces the need to explain to respondents who is covered by the questions and for what period. If information from the preceding round is provided to the interviewer, deaths, for example, can be pinpointed by naming the persons found alive at the preceding round and inquiring whether they are alive today. However, additional questions must be asked to obtain information on deaths of children born after the previous visit and deaths of other new residents. For births, the advantage is less clear but similar in principle; for example, the interviewer asks whether there are any new members of the household who were not listed at the previous visit.

Dual or multiple reporting of the same vital events may be attempted in multi-round surveys by using reference periods in follow-up interviews that overlap previous reference periods. Overlapping retrospective data of this kind create special problems of matching of vital events from various rounds in the past (Sabagh and Scott, 1973; Vallin, 1975) that are similar to those encountered in a dual-record system. There are also problems of linking persons (especially young children) recorded in one round with events (births) reported in previous rounds. It is important to distinguish such "dual measurement" surveys from independent dual-record systems, because the former do not utilize independent data collection systems.

4.3.3 Dual-Record Systems

A dual-record system for data collection is based on the principle that events missed by one system may be picked up by the other. Dual-record systems are designed expressly to attempt independent, dual or multiple reporting of the same individual vital events. A dual system usually has as one leg some type of more or less continuous, ongoing recorder subsystem that records vital events as they occur, and as the other leg an independent survey subsystem that collects individual reports of vital events for the same period.

Often a civil registration system acts as the recorder subsystem, but if not, a special subsystem can be created. A special recorder subsystem may involve regular visits at short intervals to each sample household expressly to ask for and record vital events or it may depend on a network of knowledgeable local persons who regularly report vital events to a recorder who then visits only those households for which events have been reported, verifies the events, and records them.

Usually, a baseline survey is conducted as part of the survey or the recorder subsystem, prior to activating either subsystem. As in a multi-round survey, the baseline information may or may not be used for follow-up, either by the recorder or by the interviewers in the survey subsystem. In a dual-record system, subsequent survey interviews are then done primarily to enumerate and report independently of the recorder subsystem the births, deaths, or migration that occurred during the reference period of interest. After each survey, reports from the two subsystems are matched to identify events reported in both subsystems, events reported in only one subsystem, and to make estimates of events missed by both subsystems.

The accurate matching of records requires that interviewers be carefully trained and supervised in recording identifying information. In order to minimize communication between the two subsystems, matching usually is done in the central office, in contrast to multi-round surveys, in which matching and reconciliation are usually performed at the time of interview. Usually, another field visit is required after the initial matching is performed; unmatched events and doubtful matches are returned to the field for reconciliation or for verification of the event and the reported details. After final matching, estimates of the total number of events are made, using data from both sources.

Problems have been encountered in the matching process in some dual-record systems, which can lead to over- or underestimates of fertility and mortality levels. Matching problems arise from the use of incorrect geographic boundaries for the sample areas in one or both systems or the use of incorrect recall periods in one or both systems. Also, inappropriate matching rules can lead to events being mismatched. For example, if the matching rules for the reporting of a birth require concurrence on name of child, name of father, and sample area, overly strict application of the rules could lead to a true match being classified as two nonmatches if the two workers collecting the data in the sample area each record the name of the child and the name of the father differently enough that they do not satisfy the matching rules. Difficulties arise also in the development and implementation of matching rules to allocate events that occurred to migrants before or after they entered or left the area covered by the system.

The survey component of a dual-record system can be like a multi-round survey, in that repeated visits to the same units are made, although in many survey subsystems reinterviews are conducted without using data from previous rounds. A recorder subsystem that entails repeated visits to every household also functions much like a multi-round survey. In contrast, a recorder subsystem that relies on community contacts to report events rather than visits to every household is more closely related to an active civil registration system (described in Chapter 3) than to a multi-round survey. We can thus distinguish two types of dual-record systems: (1) those in which both subsystems involve repeated interviews at each household and (2) those in which only the survey subsystem involves multiple visits. Both of these differ from "dual measurement" multi-round surveys that utilize overlapping reference periods to obtain dual reports.

4.3.4 Fertility Surveys

A fertility survey is a specialized type of single-round survey in which the principal body of data collected to measure past and current fertility (and in some cases child mortality also) is a fertility or pregnancy history. A fertility history is a set of information collected from each interviewed woman (or couple, but usually a woman) concerning all live births that have occurred to her in her lifetime or in a specified recent time period, such as five or ten years. For each child born, several items of information are usually collected: date of birth; sex; current age; if no longer living, age at death; whether or not still living at home; and whether single or multiple birth (in which case each birth is listed separately). A pregnancy history expands the scope of events to cover all pregnancies; it collects information on the outcome of each pregnancy, including stillbirths, miscarriages, and abortions as well as live births.

The persons interviewed in fertility surveys may be all women, ever-married women only, or currently married women only. Sometimes women over age 50 are included, but the most common practice is to interview ever-married women under age 50. Also, many fertility surveys include a full count by age and sex (and sometimes other characteristics) of all persons in the households selected as interview units, whether or not the household contains an eligible respondent for the fertility questionnaire. A fertility survey is much less useful for analysis if such complete counts are not obtained.

Some fertility surveys also attempt to obtain information on contraceptive use prior to the latest pregnancy or to each pregnancy, and some have tried to obtain data on whether or not certain pregnancies, usually the more recent ones, were desired by the respondent, either at that particular time or in general. For example, the survey may try to determine which of the following situations pertains to a woman who has four children: she wanted the fourth child when she had it; she wanted a fourth child at some time but not when she had it; or she did not want the child at all. Fertility surveys are often associated with KAP surveys, that is, surveys that collect data on knowledge, attitudes and practices related to family planning and family size. Some KAP surveys include summary questions about fertility, such as the number of children ever born, and hence they are similar to single-round demographic surveys. However, for the purposes of this discussion a KAP survey is not considered a fertility survey unless it includes a fertility or pregnancy history.

Fertility surveys usually are not carried out at frequent intervals, and many countries have conducted only one to date. A small number of countries (for example, Taiwan and Korea) have collected pregnancy history data at two-year intervals during certain periods in their development of family planning programs. Other countries have used longer intervals; for example, Turkey conducted a series of four fertility surveys at five-year intervals beginning in 1963. Sometimes fertility surveys are incorporated into one round of a multi-round survey or dual-record system or carried out in conjunction with a single-round survey. In these cases the fertility survey usually is administered only to women in a subsample of the households in the demographic survey.

If the data on the occurrence, timing, and survival of all live births are of good quality, fertility histories permit extensive analysis of period and cohort fertility and of infant and child mortality. As a result, the method has been widely used in developing countries and is the approach adopted by WFS. In addition to fertility or pregnancy histories, fertility surveys collect varying amounts of other information on personal and household characteristics, social and economic characteristics, marriage ages and marital history, knowledge of and attitudes toward family planning, past and current use of family planning, and migration experience, including urban and rural background. Sample sizes in national fertility surveys often range from 3,000 to 8,000 interviews, although many other fertility surveys are carried out on a local basis with smaller numbers of interviews.

4.4 GENERAL CHARACTERISTICS AND PROBLEMS OF SURVEYS

Surveys have many advantages and some disadvantages relative to the other two major methods of data collection, the census and CR/VS systems. In addition, there are relative advantages and disadvantages among the four types of surveys just described. This section describes characteristics of design and implementation that are shared by all types of demographic surveys. Two such aspects, the calculation of total error and the special problems involved in framing questions about fertility and mortality, are described in more detail in Appendixes A and B.

As a guide for the following discussion, we present Figure 4.1, which lists the major tasks and decisions facing survey planners and those who implement the plans. This checklist includes all major steps in the survey process, from sampling design and the actual collection of data in the field to editing and coding, data processing, and tabulation and publication of results. However, given the focus of this report, the discussion that follows emphasizes the steps that most directly affect the data collection process and not the logistics of tabulation and analysis, although these are also critical to obtaining good results. In fact, as a prefatory note to this entire subject it should be emphasized that success in designing and implementing surveys depends above all on meticulous attention to small details. No matter how trivial some details appear individually the integrity and reliability of most surveys stand or fall on their cumulative effects. We point out many of these details in the discussion below.

4.4.1 Type and Scope of Information Needed

The first major task is to determine what kind of information is needed. Are estimates of both fertility and mortality required for the total population--for example, estimates of the crude birth rate and total fertility as well as the crude death rate and a life table? Is it sufficient to obtain estimates of fertility and child (and infant) mortality, but not adult mortality? Will estimates of only fertility or only mortality suffice? Is the survey expected to produce data for estimating fertility trends as well as for estimating current or very recent levels?

Fertility surveys, which include pregnancy histories, can provide the data needed to estimate fertility trends, although extremely careful attention must be given to error and bias problems in such estimation. No acceptable method yet exists for estimating total and adult mortality trends from data collected in a single-round survey (of any type), although surveys that cover prospective periods of several years may provide data on trends during those periods. For both fertility and mortality, the measurement of trends is best accomplished by analyzing data collected over time in CR/VS systems and in separate censuses and surveys. Another task in this first step is to select the geographic divisions for which separate estimates are to be obtained (for example, national only, urban/rural, regions, major cities, etc.).

4.4.2 Advance Planning of Survey Operations

A second major set of tasks includes deciding who will plan the survey, who will carry out those plans, how much money can be made available for the survey, and when the fertility and mortality estimates are needed. The decisions will involve making trade-offs among many competing alternatives, as illustrated in item B of Figure 4.1.

4.4.3 General Design Considerations

General design considerations form the third major task for survey planners: Within the given budget and time constraints, what is the most reasonable and cost-efficient way to obtain the desired information?

The survey design is the complete plan for collecting and analyzing the data required to satisfy the survey objectives; hence, it should be based upon a detailed specification of the objectives, preferably in the form of the tabulations required. General objectives and general administrative and political factors may also influence the design. The design includes the following major elements: sample design and identification procedures, including cartographic requirements; questionnaire design; type of survey; the number of survey rounds; the data collection process (sources of information and how the field staff conducts interviews); design of field operations (how field staff is selected,

FIGURE 4.1 A Checklist of Major Tasks and Choices Facing Planners and Administrators of Surveys for Collecting Fertility and Mortality Data

Task	Choices
A. Decide on type and scope of information desired	1. Fertility or mortality or both
	2. Current levels or levels and recent trends
	3. Child mortality only or child mortality plus total population mortality
	4. National estimates only or separate estimates for regions, urban and rural areas, etc. (affects type and size of sample)
	5. Type of tabulations and richness of detail desired
B. Advance planning of survey operations: personnel, financial resources, and timing (who will be responsible for implementation, maximum available budget, and time frame)	1. Organization/department and individuals responsible for the survey
	2. Trade-offs among subject-matter details
	3. Trade-offs among geographic coverage possibilities
	4. Where to obtain necessary skilled personnel for all phases of survey operations, including tabulation, analysis, and report writing
	5. Trade-offs among survey objectives, time constraints, and budget constraints
C. General design considerations (how best to obtain the information within necessary time and budgetary constraints)	1. Type of survey (and whether separate survey or part of a multi-subject investigation)
	2. Type and design of sample
	3. Target population (whole country or some areas excluded)

	4. Levels of acceptable total error 5. Content and design of schedule 6. Maps and household identification procedures 7. Logistics, especially transportation
D. Detailed design of sample (choosing the optimum sample design given the objectives, the circumstances in the country, and the general design choices made)	1. Balance between sampling errors and non-sampling errors 2. Stratification 3. Clustering and area units for sample 4. Accepting ranges of sampling error
E. Detailed design consideration to deal with coverage errors and biases	1. Rules for and supervision of interviewers to minimize non-coverage and non-response 2. Control processes to minimize/eliminate overcoverage errors
F. Detailed design considerations to deal with response errors and biases	1. Ways to collect information on the basic demographic variables, including age, migration and residence, and current (recent) demographic events 2. How to collect fertility information: summary questions or fertility (pregnancy) histories or both
G. Type of schedule[a]	1. Use of questionnaire or form 2. Content and design 3. Extent of pretesting and questionnaire revision 4. Number of linguistic versions of schedule to be developed and used

trained, and deployed, how they locate sample units, assignment and control of work); flow of records; office procedures; data processing; design of reports and analytical procedures; the timetable; and cost considerations. While the design is based upon the objectives, the costs depend upon the design; hence the initial design decisions, including the advantages and disadvantages of each, are sometimes reconsidered in matching detailed objectives with available resources.

Determining the objectives and design characteristics of a demographic or fertility survey involves an initial review of whether or not the survey should be part of a multi-subject investigation and whether it should be a new single-round survey, a multi-round survey, a dual-record system, or something else. This review cannot be made without knowledge of already available demographic data and the total statistical system within which the survey will be conducted. Unless sample design requirements for different subjects differ drastically, multi-subject surveys usually are more cost-effective than single-subject surveys. Hence, it is likely that demographic data will continue to be collected in multi-subject surveys because of perceived favorable cost ratios (Bhattacharyya, 1977).

In some surveys the decision is made to deliberately exclude certain regions or classes because of inaccessibility or on other grounds. Groups frequently excluded from the target population are nomadic tribes, the armed forces, and institutional populations, such as inmates of mental hospitals or prisons. For example, in Kenya the population dwelling in the arid northern half of the country (about 5 percent of the total population) was excluded from the National Integrated Sample Survey sample because of the disproportionate cost of collecting data from them (Kenya, 1975). For similar reasons, the Sahara region was excluded from the 1969-70 Algeria multi-round survey, except for a small quota sample that was not included with the survey results (Republique Algerienne Democratique et Populaire 1971:15).

Another general design consideration is what levels of total error (which includes sampling and non-sampling components of error) will be considered acceptable by the data users. For example, different designs will be required if the data users request a national estimate of the birth rate that has a high probability of being within 3 or 4 points of the true value as opposed to a situation in which users request a crude birth rate for each of six regions in a country and require accuracy of ± 2 or 3 points. (A more complete discussion of total error appears in Chapter 1 and Appendix A.)

Other examples of design details important in surveys, as well as in other methods of collecting data for fertility and mortality statistics, are counting rules, cartography, transportation and other logistics, and language. The determination of counting rules is crucial and difficult in surveys, with choices to be made about de facto versus de jure enumeration of survey households (see UNECA, 1974). Separate sets of rules must be developed for counting the population and for counting vital events.

Maps that show identifiable boundaries for each sample area are essential for identifying area units in the field. Maps are particularly important for sample areas in shantytown or slum areas of cities, and for scattered rural settlements; they are less important for compact villages, unless sample areas consist of only parts of those villages. Sometimes a recent census can provide maps and initial lists of dwelling units that can be used in a survey, although the lists must be updated. In the absence of household listings that correspond to areas or administrative units, it may be necessary to resort to two-stage or multi-stage sampling, that is, draw a sample of administrative units, then prepare maps and listings for those sample areas only. This approach depends on the availability of existing data adequate to define a sampling frame. Area sampling, in at least one stage, is required for virtually all surveys in developing countries. For this, maps are needed, and survey designers must determine how the maps will be obtained.

Arranging for adequate transportation is another seemingly straightforward but critical factor in launching a survey. Other logistical details to be planned for in advance include provision of office space, lodging for field staff, procurement of field equipment, and arrangements for the flow of records to the central office.

Language and ethnic differences are another design detail that requires careful attention. Many developing nations have more than one language or dialect and some have many. To collect the most accurate data, interviewers and respondents need to be able to understand each other clearly with minimum reliance on interpreters. Thus the need for more than one linguistic version of the questionnaire and special assignment of interviewers should be considered in the planning stages. Also, survey designers should attempt to anticipate potential problems arising from ethnic differences. In some cases, interviewers from one group should not be assigned to interview respondents from other groups.

Because all these elements of survey design cannot be considered in isolation, there is naturally interaction and feedback among the persons involved and decisions made in accomplishing tasks A, B, and C shown in Figure 4.1. Ultimately, the type of estimates desired defines the data requirements. Data requirements in turn determine questionnaire content, which determines how specific questions must be formulated. The nature both of the questions to be asked and of the respondents to be interviewed determines the ideal interviewer, which, along with available modes of transportation, lodging, and communications systems, determines what options may be available for selection, training, and organization of the field staff. Whether a field survey organization is already in place or must be created anew determines how much time it will take to conduct the survey as well as the quality of data and its production on a timely basis. These attributes determine in part the requirements for central staff and management, field strategy, and facilities for data processing and analysis. In turn, shortages of skilled staff and of data processing facilities can place constraints on the level of organization achievable, on the questionnaire design that can be utilized, and on the production of high-quality data on a timely basis.

The final design should be practical and simple enough to be implemented by the available staff, even when it may be considered to be inefficient in other respects. A useful maxim for the design process has been provided by O'Muircheartaigh (1977:82): "In real life, . . . optimization is impossible....Proximization implies an aspiration to excellence combined with sufficient understanding to realize that perfection is unattainable."

4.4.4 Effects of Sample Design on Error

As described above, the measurement of fertility and mortality data through household interviews and fertility surveys is subject to several types of error. As indicated in Figure 4.1, the first major choice affecting the detailed sample design concerns balance. A reasonable balance must be struck between (1) the sampling errors, which are decreased (for any given design) primarily by increasing the sample size; and (2) systematic biases and correlated measurement errors, which are decreased primarily by exercising better statistical control and using improved data collection techniques. This balance can be achieved only through the coordinated efforts of the subject-matter specialist, the sampling statistician, and persons with intimate knowledge of the administrative and cultural settings in which the survey will be carried out.

4.4.4.1 *Sample Size*

Sampling error is affected by the size and design of the sample. A frequent misconception is that the most important factor in sampling error is the sampling fraction. However, the key element is not the sampling fraction but rather the absolute size of the sample for the group or subgroup for which the estimates are desired. Also, work load considerations and other operating issues affect the choice of sample design.

If a smaller level of error is required for planning or evaluation purposes, a larger sample can be used. For example, if simple random sampling were applied in a population (it is almost never applied, although it is approximated) for which the true crude birth rate is around 35, a sample size of 5,000 persons would provide estimates of the rate that are within about 5 points of the true value 95 percent of the time, or 35 ± 5.2 (assuming that only sampling error is considered). Under the same conditions a sample size of 15,000 persons would reduce the estimated sampling error to 35 ± 3.0. As sample size increases, other survey conditions, such as supervision, training, amount of field work, and cost, are directly affected. The effects of cluster sizes and other design effects are discussed below.

4.4.4.2 *Stratification*

It is also possible to reduce sampling error by using a stratified design, creating strata such that sampling units within each stratum tend to be somewhat similar to each other with respect to the variable being measured than to units in other strata. For example, sampling independently within urban and rural areas of the country will reduce somewhat the sampling error of fertility measures. If estimates are required for subdivisions of the country, stratification may also be required in cases where a subdivision is so small that it would not get a large enough sample allocation; in this situation, the designer may treat that subdivision as a stratum and arrange to "over-sample" it, or perhaps use double sampling to oversample a subset.

4.4.4.3 *Clustering and Design Effects*

In demographic surveys that use a census-type questionnaire it is usually desirable to interview all people in the selected area units, a technique sometimes called compact cluster sampling. This simplifies the field work by eliminating the need to sample dwellings or households within each area unit. This kind of sample design is generally considered indispensable in a multi-round survey or dual-record system in order to ensure comparable coverage from round to round.

The survey designer always has some choice of the size of area unit to use for sampling. If the units for which a sampling frame already exists are too large, mapping and splitting can be used to create smaller units. The number of individuals selected from the final-stage area unit is usually called the "cluster size." In the case of compact cluster sampling this will equal the population size of the area unit. Thus, cluster size is under the control of the sample designer.

In real life, neighbors tend to resemble each other more than people who live far apart; this principle holds for mortality and fertility. Common sense suggests, therefore, that it is less informative to interview large numbers of people in each cluster than to spread the sample out over many clusters. This inference is correct and is reflected in the fact that, for a given total sample size, sampling error is higher the larger the cluster size. On the other hand, survey costs are higher the smaller the cluster size. These two effects are opposed, and in a survey to estimate a single variable there is thus an optimum cluster size per unit cost that minimizes sampling error and which can be estimated if certain assumptions are made (Hansen et al., 1953).

Resemblance between neighbors, the clustering of the population into groups of similar people, may be measured by the ratio of homogeneity roh. Essentially this measures the proportion of total variance between individuals that is attributable to variation between clusters. If within a stratum everyone in the same cluster falls in the same category on a given characteristic, and there is variability between and only between strata, then roh = 1 for that characteristic. If the characteristic is distributed at random among clusters, then roh = 0.

In the 1960s, Scott and Coker (1971) calculated the value of roh for several variables, based on surveys in developing countries. Some examples of the range of roh were .001 to .003 for the crude birth rate, and .002 to .004 for the crude death rate.

More recently, the WFS surveys have provided the basis for the investigation of the pattern of sampling error (Verma et al., 1980). Table 4.1 presents the median values of roh for five groups of variables included in 12 WFS surveys. A total of 38 variables were used in these calculations, representing variables defined almost identically in the 12 countries and covering the estimates of substantive interest from the WFS core questionnaire for the women's survey (Verma et al., 1980:449).

There is much variability in these roh values. Averaged over the 12 countries, the median roh is around 0.02 for nuptiality and fertility variables, around 0.03 for fertility preference variables, and around 0.05 for contraceptive use variables, while values are much higher (around 0.08) for variables concerning contraceptive knowledge (Verma et al., 1980:445). These roh values are based on populations of ever-married women of childbearing age, and therefore they are not comparable to the roh values cited above for crude birth and death rates for which the base is the total population.

The value of roh is reduced by efficient stratification. It also falls as the size of the area unit increases (Adlakha et al., 1977), but it does so only slowly. More important, as shown in Table 4.1, it varies widely according to the variable considered.

The fundamental formula for reasoning about cluster size is:

$$V = V_o[1 + (n - 1)\underline{roh}]$$

where V is the sampling variance for the actual survey design used

V_o is the sampling variance for a random (unclustered) sample of the same total sample size, and

n is the cluster size, assumed constant.

The term in brackets [1 + (n - 1) roh] is called the design effect, or deff. The quantity square root of deff is sometimes called deft. For most subclasses, such as age or education, one should think of $n' = \bar{M}n$ where $\bar{M}$ is the proportion in the subclass. For example, $\bar{M}$ equals about one-fifth for age-specific fertility rates in five-year age groups (Kish, 1965:257; Verma et al., 1980; Kish et al., 1976).

Verma et al. (1980) have also calculated values of deft for 12 WFS surveys. They note that by taking the ratio of a standard error (se) to its simple random sampling equivalent (sr), "one eliminates factors which influence se and sr in similar ways, factors such as the scale of measurement and magnitude of the estimate itself, the standard deviation and the overall sample size" (Verma et al., 1980:444). The results show generally little variation in average deft for the three groups of variables on nuptiality, fertility, and fertility preference, with most of these deft values between about 1.1 and 1.6 for the 12 countries. In fact, for variables other than contraceptive knowledge and use, average defts for the total sample do not exceed 1.3 in 8 of the 12 countries (Verma et al., 1980:Table 3). However, the authors note (1980:444-445):

> "Deft is much larger for variables concerning contraception, particularly contraceptive knowledge. This is not unexpected since, in many developing countries where the introduction of family planning is relatively recent, contraceptive use and, even more so, contraceptive knowledge tend to be localized effects which the geographical stratification usually employed is too coarse to remove. More surprisingly, the attitudinal variables on fertility preferences do not show notably larger design factors than the demographic variables. . . . The highest average deft found is for contraceptive knowledge variables in Nepal, where deft = 3.21 imples a ten-fold increase in variance due to clustering of the sample; in four other countries (Mexico, Thailand, Indonesia and Colombia) this increase is over five-fold; it is around two- or three-fold for other countries except for Costa Rica (in which the level of contraceptive knowledge is almost 100 per cent in any case)."

FIGURE 4.1 (Continued)

Task	Choices
H. Training of field workers	1. Type and duration of training 2. By whom
I. Detailed design of field operations	1. Timetable 2. Use of existing or newly created survey organization 3. Supervision 4. Transportation and other logistics 5. Size of field staff, especially number of interviewers 6. Making interview assignments on a team basis or for each individual interviewer
J. Control functions	1. Control during sampling phase 2. Control during field operations 3. Control during processing and tabulation phases 4. Management records
K. Data processing and tabulation	1. Where and by whom (including programming) 2. Extent of quality control 3. Use of imputation 4. Mechanism for interaction with survey designers
L. Methods of disseminating survey results	1. Number and type 2. Number and levels of professional staff to analyze data and prepare reports 3. Computer facilities for technical analysis beyond tabulations

4. Provision for generation of subsequent tabulations through data base, access to tapes, etc.

---

[a] In this report, the word "schedule" is used as a general term meaning the tool used to physically record information. The two basic types of schedules are referred to as questionnaire and forms. As used here, a "questionnaire" is a schedule that contains each question exactly as it is to be asked in the interview or read by a respondent who is filling in the responses on a self-administered questionnaire. In a "form," subject items are listed only in summary terms, and instructions on how to ask for the information are provided in instruction guides and described in the training process. Forms are frequently arranged as tables, with one row for each respondent. For example, here is how the same information might be indicated on a questionnaire and a form.

Questionnaire
What is your name? ______________________
How many years did you complete in school? __________ years
What is your usual occupation? ________________

Form

Name	Age	Education	Occupation
____________	______	_______	______________
____________	______	_______	______________
____________	______	_______	______________

TABLE 4.1 Median Values of roh by Variable Group in WFS Studies in 12 Developing Countries

	Variable Group					
Country	Nuptiality	Fertility	Preferences	Knowledge	Use	All Variables[a]
Mexico	.03	.06	.03	.17	.11	.07
Peru	.01	.04	.05	.14	.09	.05
Jamaica	.04	.03	.07	.09	.04	.05
Indonesia	.02	.02	.05	.14	.06	.05
Sri Lanka	.02	.03	.03	.07	.07	.05
Thailand	.01	.01	.02	.08	.06	.03
Guyana	.02	.05	.03	.08	.03	.03
Nepal	.02	.02	.05	.05	.03	.03
Colombia	.01	.00	.01	.05	.04	.02
Bangladesh	.01	.01	.02	.06	.03	.02
Fiji	.02	.00	.02	.04	.02	.02
Costa Rica	.01	.02	.00	.01	.02	.01
All[a]	.020	.025	.030	.080	.050	.040

[a] Average of median values. Countries arranged according to last column.

Source: Verma et al. (1980:449).

The basic formula for cluster size shows clearly that where roh is large the cluster size should be kept small. For example, where roh is .1, using a cluster size of 100 would mean a tenfold increase in the error variance, compared with a random sample.

If an assumption about costs is made, it is possible to relate costs within clusters to costs between clusters, in order to compute for a single statistic the cluster size that will yield minimal sampling error for a given cost. However, other design factors will also affect the optimal cluster size, including the type of survey, acceptable error limits, and the relationship between effective supervision and the extent of scattered sample areas.

By extrapolating roh (or deff) from earlier comparable surveys, the survey designer can make an advance estimate of sampling error for differing cluster sizes and differing total sample sizes and use these estimates in designing the details of the survey. If one believes that the stratification will be more efficient than in earlier surveys, a smaller roh can be assumed; if one is using smaller area units, a larger roh can be assumed; if team interviewing is used instead of individual interviewing, the cost function will be modified. Thus, in principle the survey designer has a tool for roughly optimizing the main parameters of the sample design. The main practical limitation is the fact that each of the survey variables being investigated (fertility, mortality, age distributions, etc.) is likely to lead to a different optimum, and therefore there is a range of the optimum that must be considered.

4.4.4.4 *Precision of Estimates (Sampling Error)*

For a simple random sample of n people (never practiced), if the birth or death rate is considered a proportion and if there is no clustering, the variance is approximately binomial, i.e., the variance of the rate is pq/n where p = rate per person and q = 1 - p. Using these relationships, the effect of cluster size and roh on the expected 2-sigma confidence intervals for different crude birth and death rates have been calculated and are shown in Table 4.2.

Examples of the ranges of these estimates are shown in Table 4.3. For example, with a sample size of 1,000, roh equal to .008, and a cluster size of 125, the size of the

TABLE 4.3 Ranges of Estimates (Confidence Intervals) Derived for a Crude Birth Rate of 40 as the Sample Size, Cluster Size, and Ratio of Homogeneity Are Varied

roh	Size of Sample (total number of persons)	Size of Cluster (number of elements) 125	250	500
.008	1,000	35.0	42.8	55.4
	100,000	3.6	4.2	5.6
.001	1,000	26.2	27.8	30.4
	100,000	2.6	2.8	3.0

Source: Table 4.2.

confidence interval (or range of estimates) is 57.5 - 22.5 = 35.0. Note that for a given sample size the range of the estimate increases with cluster size. Note also that when roh is very low (here .001), the effect of cluster size is much reduced. Naturally, the size of the sample has a major effect on the confidence intervals.

A comparison of the ranges of 2-sigma confidence intervals for estimated age-specific fertility rates and estimates of crude birth rates, given identical total population size and identical sample size, shows that there is a wider range for the estimates of age-specific fertility rates, that is, there is less precision in the measurement of the age-specific rates. Other factors being equal, estimates of cumulative fertility have substantially smaller sampling errors than estimates of the crude birth rate or age-specific fertility rates because they incorporate many more woman-years of experience. Age-specific fertility rates based upon periods longer than 12 months would also be subject to lower sampling errors, although they might be subject to greater nonsampling errors because of problems of recall (Seltzer, 1973).

4.4.5 Coverage Errors and Biases

There are two types of coverage error that can cause estimates to be biased: undercoverage and overcoverage.

Both of these may be reduced by adequate attention to planning and administration of the survey. The causes of undercoverage include the following:

(1) Omission of units from the survey due to use of an incomplete sampling frame. At best, this produces a sample that is representative of the incomplete or inappropriate sampling frame. For example, if only 14 out of 16 provinces in a country were covered, the results would be biased if they were taken to be representative of the country as a whole.
(2) Omission of units from the sampling frame because they are missed in the mapping or listing process.
(3) Units that are selected and correctly included in the mapping and listing process may be missed later for various other reasons:

    (a) The interviewer may fail to contact the household and complete an interview even after repeated call-backs. For example, the interviewer may first attempt to contact the household when no one is at home; if no call-backs are made, this would become a missed interview. Thus, the level of coverage is strongly influenced by the rules for call-backs applied in the field.
    (b) The eligible respondent may be incompetent or ill or have some language difficulty that renders the interview impossible.
    (c) An eligible respondent may refuse to respond to the interviewer.
    (d) Errors may exist in the interviewer's instructions or in the data used to determine a respondent's eligibility for interview.
    (e) Errors may arise in the interpretation by interviewers or field supervisors of the instructions or data determining eligibility for interview.
    (f) A serious omission can occur when a batch of completed questionnaires is lost in transit between the field and the headquarters or during processing.

A factor that enters into many of the above is laziness, which may occur on the part of interviewers (who cannot be bothered to visit all the households) or on the part of field supervisors (who are not alert in discovering such practices in the early stages of field work).

Overcoverage also arises from a wide variety of practices, including:

(1) Duplications in the sample frame, causing some units to be oversampled without detection. (This may happen, for example, in shantytown dwelling units, which have no addresses.)

(2) Listing or mapping errors that lead to the undetected inclusion of ineligible units in the sample. (A sample that includes ineligible units is not a problem in overenumeration if such units are treated properly, i.e., as ineligibles.)

(3) Inadequate control of field work that allows interviewers to obtain duplicate interviews or questionnaires from the same interview unit or parts of the interview unit.

(4) The creation of duplicate cards or data tapes that are erroneously included in tabulations at the data processing stage. (This is not meant to refer to the duplicate cards or tapes that are sometimes prepared and deliberately included in tabulations to give increased weight to certain sample units or to provide imputation of missing values. However, the practice of imputation has caused problems in both surveys and censuses. When imputation is used, it is best to produce two sets of tables, one including the imputed values and the other showing only the original values. See Section 2.7.2 in Chapter 2 for a discussion of imputation.)

Levels of coverage error can be controlled only by exercising extreme care in accounting for every sample area and interview unit at every stage of work. At the analysis stage all available data on coverage errors should be used to detect possible biases and to aid in adjustment and interpretation of the data.

In addition to the errors of undercoverage and overcoverage associated with sampling units, there can be under- and overcoverage on particular items or events. In addition to unit nonresponse, respondents may refuse to answer some of the questions, resulting in item nonresponse. For example, less complete information may be obtained from a question on "currently pregnant" or "occupation of head of household" than on other items.

Births in the last year may be under- and overreported. Deaths in the last year are frequently underreported.

In some circumstances, something generally considered a response error can contribute to coverage error. For example, a fairly common type of interviewer error (and consequent bias in fertility estimates) is the failure to distinguish between an answer of zero and a response of "don't know" or "not stated" to questions on parity. El-Badry (1961) describes this particular type of error and provides an estimation procedure for adjusting the data. The error frequently arises in the collection or processing of information on children ever born (CEB) if, for example, a survey interviewer or census taker puts a dash (--) on the form when a respondent's answer is zero or none and this dash is then coded or punched on data cards as "not ascertained." The problem arises particularly among women aged 15-19 and to a lesser degree among women aged 20-24, those most likely to be childless. In cases where the proportion of "not ascertained" cases is much larger in these younger age groups than for women as a whole, El-Badry's correction process transfers a portion of the "not ascertained" cases in these younger age groups to the zero-parity category.

This problem of distinguishing clearly between different answers that may appear similar to interviewers and coders can arise with other items, especially on those for which it is important to distinguish between "don't know" and "not ascertained." Coders should be instructed to distinguish these responses clearly, and questionnaires and coding should be designed with such potential errors in mind.

4.4.6 Response Errors and Biases

In theory, response variance and biases are separate components of total error. Response variance can be measured by replication methods, however the measurement of bias requires access to independent sources of information, which is not always possible. Usually it is difficult to obtain estimates of the combined error due to response variance and biases.

In many cultures, two of the most basic types of demographic variables--age at time of survey and the date of occurrence of past events such as births, deaths, marriages, and migration--are not reported accurately

(Seltzer, 1973; Ewbank, 1981). These and other difficulties are present in every demographic measurement system, but some present special difficulties. In the sections below we discuss response errors and biases in the two areas that have special bearing on the estimation of fertility and mortality: the collection of data on children ever born (CEB) and the collection of data related to mortality estimation.

4.4.6.1 *Response Errors in Data on Children Ever Born*

There are a number of typical response errors that occur in CEB data, regardless how they are collected. The errors fall into two general categories: faulty omissions and faulty inclusions.

(1) Faulty omissions
    (a) children who died in infancy
    (b) children who left the home
    (c) children born of a husband other than the current one
    (d) children given out in adoption
(2) Faulty inclusions
    (a) stillbirths reported as children who died in infancy
    (b) children borne by another wife to the current husband
    (c) adopted children
    (d) grandchildren

Clearly, the magnitude of these errors will determine the accuracy of fertility estimates based upon such data. Errors of omission and inclusion may tend to cancel each other.

The Use of Fertility Histories vs. Summary Questions
Two ways in which surveys collect CEB data are (1) to sum up live-birth information obtained in a fertility or pregnancy history, and (2) to ask summary questions on the total number of births and surviving children (the summary Brass questions described in Chapter 1 and Appendix B). It has been generally believed that the fertility or pregnancy history approach yields more complete and accurate information on past fertility than can be provided by one question on CEB or by a set of three or six summary questions (Marckwardt, 1975).

However, Hobcraft's (1980) study in Colombia suggests that there may sometimes be little difference between the two approaches. Much of the other existing evidence is inconclusive, because while fertility histories are collected from the woman herself, the summary questions may be asked of proxy respondents, who may provide less accurate information than the primary respondent. Also, despite the advantages of the history approach, many surveys (and all censuses) are designed in ways that make it impossible to include a fertility or pregnancy history, except perhaps with a subsample. However, nearly all surveys (and many, if not most censuses) would not be overburdened by the inclusion of the three or six questions on CEB and children surviving. The WFS Core Questionnaire uses the summary questions as an introduction to the fertility history.

There are a number of studies that have compared the fertility history and summary question approaches to collecting CEB data. In the baseline survey conducted to begin the dual-record system used in Kenya, contiguous pairs of areal clusters were selected and individuals in each pair were randomly allocated to interviewers using one of two different schedules to obtain CEB data. One schedule asked for a fertility history (FH); the other contained the six summary questions (SQ) on children ever born. (However, it should be noted that the fertility history schedule used was an abbreviated one; interviewers did not ask specifically about "live-born children who are now dead.") On the average, the fertility histories reported fewer children in both categories, CEB surviving and CEB dead at the time of interview (Kenya, 1975 and 1977). Two years later, the same type of data collection was repeated in a subsample of the same pairs of clusters and a third (new) contiguous cluster was added to each pair. Respondents in the new clusters were asked the summary questions first and then the fertility history questions, and interviewers were instructed to reconcile any differences between the two sets of responses. The results of the two surveys are shown in Table 4.4 and plotted in Figures 4.2 and 4.3.

In the baseline survey of 1973 (Figure 4.2), differences between the summary questions and birth history are clear, with the summary questions producing higher averages for both children still living and children now dead, although for the latter the differences are much greater. In the retrospective survey of 1975 (Figure 4.3), the pattern of differences

TABLE 4.4 Average Number of Children Ever Born per Woman by Age Group, Type of Schedule, and Whether Children are Still Alive or Now Dead: Kenya

Part A. Baseline Survey, 1973[a]

Age Group of Woman	CEB Still Alive		CEB Now Dead	
	FH	SQ	FH	SQ
15-19	0.35	0.43	0.03	0.05
20-24	1.58	1.80	0.12	0.24
25-29	3.13	3.57	0.21	0.59
30-34	4.57	4.88	0.43	0.95
35-39	5.22	5.68	0.73	1.32
40-44	5.63	5.96	0.89	1.75
45-49	5.86	5.76	1.00	2.10
All	2.87	3.10	0.33	0.68
Average Difference (SQ - FH)		+0.23		+0.35

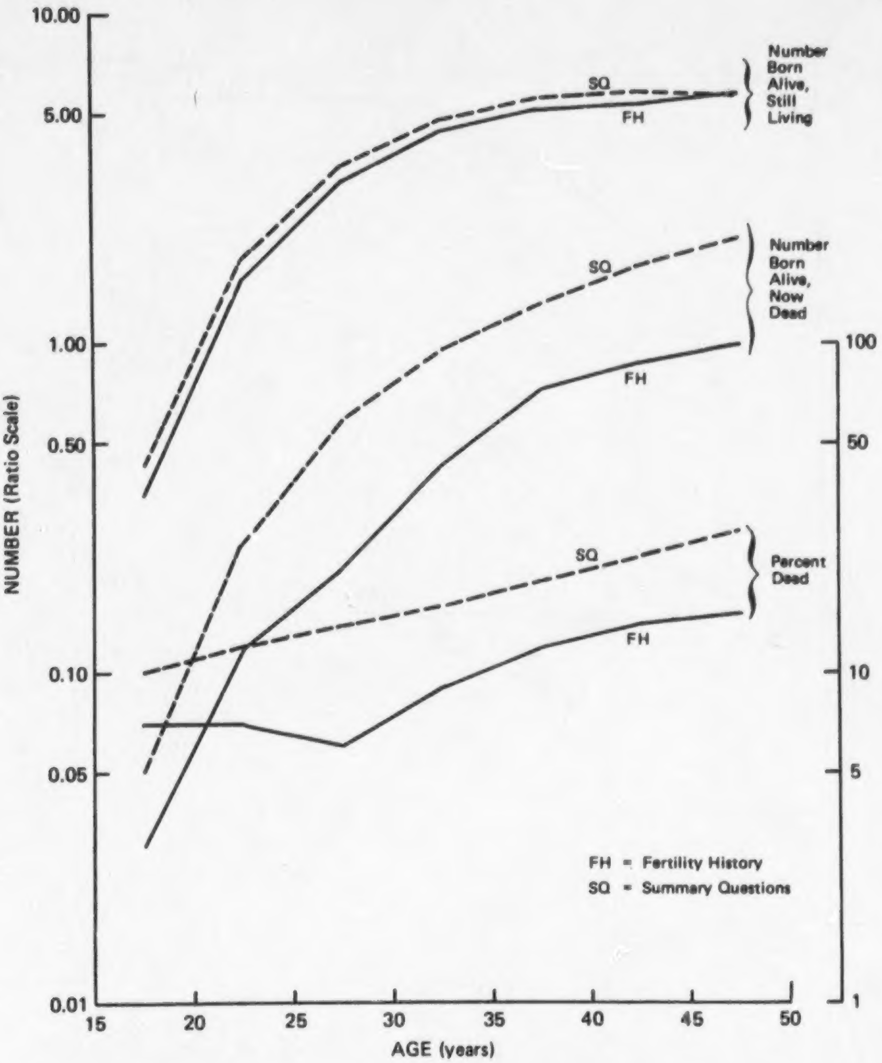
Part B. Retrospective Survey 4, 1975

Age Group of Woman	CEB Still Alive			CEB Now Dead		
	FH	SQ	R	FH	SQ	R
15-19	0.34	0.26	0.32	0.05	0.03	0.01
20-24	1.72	1.66	1.59	0.15	0.22	0.16
25-29	3.02	3.27	3.12	0.27	0.52	0.40
30-34	4.31	5.07	4.48	0.54	0.88	0.55
35-39	5.67	5.80	5.70	0.78	1.06	0.92
40-44	5.96	6.16	5.83	1.14	1.57	1.01
45-49	6.03	5.97	5.88	1.20	2.04	1.28
All	2.88	3.13	2.88	0.40	0.63	0.42
Average Difference (SQ - FH)		+0.25			+0.23	

Key: FH = Fertility history
SQ = Summary questions
R = Reconciliation method (see text for details)

[a] Includes only those clusters that were later covered by the Retrospective Survey 4.

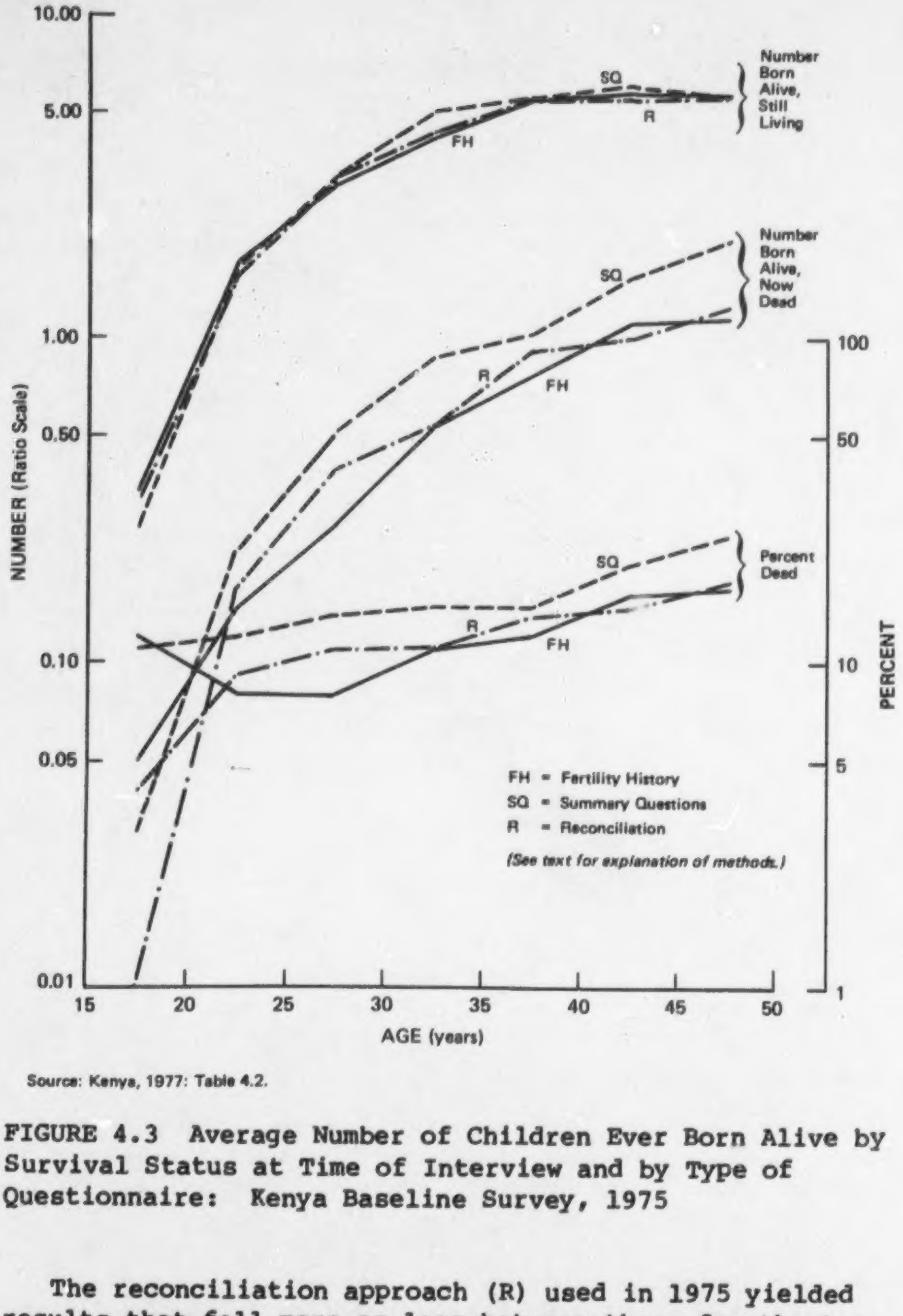
Source: Kenya (1977).



Source: Kenya, 1977: Table 4.2.

FIGURE 4.2 Average Number of Children Ever Born Alive by Survival Status at Time of Interview and by Type of Questionnaire: Kenya Baseline Survey, 1973

for children still living within age groups is more variable than in 1973 but the average difference is about the same in both years, 0.23 and 0.25 (Table 4.2). In 1975, fertility histories still yielded lower numbers of children now dead, with the exception of the 15-19 age group.



Source: Kenya, 1977: Table 4.2.

FIGURE 4.3 Average Number of Children Ever Born Alive by Survival Status at Time of Interview and by Type of Questionnaire: Kenya Baseline Survey, 1975

The reconciliation approach (R) used in 1975 yielded results that fell more or less between those for the two other approaches but somewhat closer to fertility history results. This suggests that in case of discrepancies either interviewers disobeyed instructions and adjusted the data from summary questions to conform with the fertility histories; that some fetal deaths were reported as infant deaths in responses to the summary questions; or both. Note that these findings would not necessarily apply in situations where a full pregnancy history (including stillbirths) was collected.

In two small subsamples in a survey in Niger (Piche, 1974), summary questions also produced reports of higher levels of CEB and surviving children than did fertility histories. However, in the Mysore Population Survey (U.N., 1961), fertility histories produced somewhat higher averages than did summary questions.

There are a number of possible reasons for these response biases. Perhaps women get tired of responding to a detailed fertility history and thus do not report all their pregnancies or live births. Alternatively, when summary questions are asked, there may be a tendency to report stillbirths and fetal deaths as children born live but now dead. Although the two approaches resulted in widely different estimates of infant mortality levels in Kenya, estimates of the crude birth rate based upon the reported number of births in the previous year were essentially the same for both sources (Kenya, 1975). Moreover in the Kenya Fertility Survey, executed under the WFS program, the fertility-history approach yielded substantially higher estimates of both fertility and child mortality than in any of the studies mentioned above (Kenya 1980). This suggests that the biases noted above are avoidable.

Using data collected in the Colombia 1976 National Fertility Survey, Hobcraft (1980) compared current fertility estimates based on data from a household survey, from an individual survey that included a pregnancy history, and from application of the own-children technique to responses to the household survey. The estimates are shown in Table 4.5.

Although it has been argued that the intensive pregnancy history collected in the individual survey should provide more accurate estimates of fertility than the simpler question on date of last live birth used in the household survey (for example, Marckwardt, 1975), this was not the case in the Colombia survey. For women included in both surveys, the total fertility rates reported were very similar for the two approaches, the household survey estimate being 4.55 and the individual survey estimate 4.48. This consistency, notes Hobcraft, "is perhaps surprising, because the individual woman was of necessity the respondent at the individual interview, TABLE 4.2 2-Sigma Confidence Intervals for Estimates of Crude Vital Rates Based on Given Sample Size, Cluster Size, and Ratio of Homogeneity

True Vital Rate	roh	Size of Sample (total number of persons)	Size of Cluster (number of elements per cluster)			
			1	125	250	500
Crude Birth Rate = 40	.008	1,000	27.6-52.4	22.5-57.5	18.6-61.4	12.3-67.7
		5,000	34.5-45.5	32.2-47.8	30.4-49.6	27.6-52.4
		10,000	36.1-43.9	34.5-45.5	33.2-46.8	31.2-48.8
		50,000	38.2-41.8	37.5-42.5	37.0-43.0	36.1-43.9
		100,000	38.8-41.2	38.2-41.8	37.9-42.1	37.2-42.8
	.001	1,000	27.6-52.4	26.9-53.1	26.1-53.9	24.8-55.2
		5,000	34.5-45.5	34.1-45.9	33.8-46.2	33.2-46.8
		10,000	36.1-43.9	35.8-44.2	35.6-44.4	35.2-44.8
		50,000	38.2-41.8	38.1-41.9	38.0-42.0	37.9-42.1
		100,000	38.8-41.2	38.7-41.3	38.6-41.4	38.5-41.5
Crude Birth Rate = 15	.008	1,000	7.3-22.7	4.1-25.9	1.7-28.3	0-33.2
		5,000	11.6-18.4	10.1-19.9	9.1-20.9	7.3-22.7
		10,000	12.6-17.4	11.6-18.4	10.8-19.2	9.6-20.4
		50,000	13.9-16.1	13.5-16.5	13.1-16.9	12.6-17.4
		100,000	14.2-15.8	13.9-16.1	13.7-16.3	13.3-16.7
	.001	1,000	7.3-22.7	6.8-23.2	6.4-23.6	5.6-24.4
		5,000	11.6-18.4	11.4-18.6	11.2-18.8	10.8-19.2
		10,000	12.6-17.4	12.4-17.6	12.3-17.7	12.0-18.0
		50,000	13.9-16.1	13.8-16.2	13.8-16.2	13.7-16.3
		100,000	14.2-15.8	14.2-15.8	14.1-15.9	14.1-15.9

TABLE 4.5 Estimates of Total Fertility Rate Derived from Various Data Sources: Colombia 1976 Fertility Survey

Data Source	Total Fertility Rate
Household Survey[a]	
All estimates based on births in previous year, from a question on date of last live birth.	
All women	4.37
Women also interviewed in individual survey	4.55
Women not interviewed in individual survey	4.24
Individual Survey	
Estimates based on:	
Births in previous year, from pregnancy history	4.48
Twice the proportion 4 to 9+ months pregnant	3.62
Thrice the proportion 4 to 7 months pregnant	3.63
Own-Children Estimates	
Based on household survey data.	4.13

[a] The estimates for the three groups reflect different weighting schemes, used to account for differential representation by urban/rural residence and education. For all women, the estimate was weighted. For individual interviewees, it was unweighted (because that sample was self-weighting). For once-reported women (those interviewed only in the household survey), the estimate was adjusted by weighting it more heavily than the all-women sample, to account for the removal of the self-weighted sample of twice-reported women (the women interviewed in both surveys).

Source: Hobcraft (1980:16, Table 2.1.)

whereas a proxy may well have responded on her behalf at the household survey" (1980:16).

The Effects of Proxy Reporting Based on analysis of the 1969 Peruvian National Fertility Survey, Marckwardt concluded that a short interview form using summary questions was inferior to an in-depth fertility history interview in measuring current and cumulative fertility but noted, "Most of the deficiency...can be attributed to accepting information from other household members or neighbors when the woman herself was not available"

(Marckwardt, 1973:639). On the short form, information was collected about the woman's age, total live births, live births in the 12 months preceding the interview, children who had died and their ages at death. One third of the women in the survey were interviewed using the fertility history form and two thirds were interviewed with the short form.

Marckwardt suggests that analyzing data on type of respondent might improve estimation procedures: "Analysis of the characteristics of non-respondents to the [in-depth] interview and the short-interview proxies suggest that in Peru, as elsewhere, women who are difficult to interview are different" (1973:656). In 55 percent of the short forms, answers were provided by the woman herself, while in the remaining 45 percent of cases someone else answered; few call-backs were required. Through the use of repeated call-backs, 89 percent of the women selected for the fertility history were interviewed themselves. Presumably about 34 percent of them (89 percent minus 55 percent) required at least one call-back visit; however, all self-reporting women, regardless how difficult they were to reach, were lumped together for analysis. In Peru, unlike in Kenya, data on the proportions of children born alive and now dead by age of mother were similar for both schedules, and hence indirect estimates of infant mortality levels were also similar. The Peruvian experiment suggests that further work is necessary to sort out the effects on CEB reporting of different forms of interviews and of proxy reporting.

Tuygan and Cavdar (1975) describe the results of self reporting versus proxy reporting in an experimental survey in Turkey. In areas designated as "special," interviewers were instructed to interview the woman herself to obtain detailed CEB data. In other areas, designated "normal," the interviewers were instructed to interview "a responsible household member." The authors conclude that "reports from women themselves as well as from proxy respondents* may be relatively more accurate in the special than the normal interviewing situation," perhaps because the special instructions given to interviewers made them more sensitive to the problem of obtaining reliable data (1975:27). Women reported by proxy respondents had more schooling than women who reported for themselves.

---

*Although the instructions for the special areas were to interview the woman herself, in some cases proxy respondents provided the CEB information.

For the Philippines, Madigan and Herrin (1973) and Madigan (1973) report that higher average numbers of CEB are reported by self respondents than by proxy respondents but that similar levels are reported for children surviving. Differences between self and proxy reporters were much greater for women below 30 years of age than for older women.

The Colombia survey described above (Hobcraft, 1980) also provides information on the effect of proxy reporting on estimates of current fertility. Table 4.6, which shows the proportions of women in different interview subgroups reporting a birth in the year prior to the survey, offers some evidence that the proxies underreported the women's fertility on average. However, Hobcraft urges caution in interpretation of the results (1980:16-17):

> On a superficial examination of the responses on births in the last year from the household survey alone [last two columns], it would have been tempting to infer that the substantial differences in current fertility levels between the self-reporters and the proxy reports were due to the very fact of proxy reporting. However, the availability of the individual interview with these same women makes such a conclusion untenable. A comparison of the first two columns of [Table 4.6] suggests that the differences arise mainly through the women for whom the proxy reports were made being different in fertility-related characteristics, such as urban/rural residence, work status. The women for whom proxy reports were made were also younger on average, but this should not unduly affect our comparisons on current fertility as we are controlling for age.

4.4.6.2 *Response Errors in Data Related to Mortality Estimation*

Direct questions about "deaths in the past 12 months" or some other recent period have not yielded plausible direct estimates of mortality rates. In some cases, techniques for evaluating and adjusting such data have provided satisfactory estimates, at least for adult mortality, but in other cases very low coverage or other severe distortions have meant that no serious mortality estimates can be salvaged from the data. For this reason, analysts have devised a number of indirect estimation techniques, which use data on the proportion of surviving children either by age of mother or by duration of marriage of the mother to estimate childhood mortality, and data on orphanhood or widowhood to estimate adult mortality.

The methods to estimate childhood mortality have been used extensively and have produced fairly satisfactory results. Orphanhood questions on survival of mother have been used in a number of censuses and surveys in Africa and Latin America, and the broad levels of adult mortality that they imply generally have looked reasonable, even though the detail of the results--for example, mortality by age--is often unsatisfactory. The use of data on widowhood to estimate adult mortality is more experimental and results have been mixed; in some cases the procedures have worked quite well and in other cases rather poorly. The value of both orphanhood and widowhood methods has been increased by the recent development of procedures that calculate a time reference for the estimates.

The age-of-mother and marital-duration estimates of childhood mortality are both affected by errors of omission or inclusion in CEB data. These and other potential problems must be considered and tested in the process of questionnaire design. In theory the marital-duration model is intended to be based on data from women in their first marriage, which would require a question on whether the current marriage is the woman's first marriage, as well as questions to determine either the date of the first marriage or the time elapsed since first marriage. (In practice the method is applied to all ever-married women by measuring marital duration as time elapsed since date of first marriage.) These data are used along with information on all children ever born and surviving in estimating childhood mortality.

The main problem in collecting data to be used in widowhood estimation techniques arises from the fact that the analysis is intended to be applied to survival of the respondent's first spouse, in order to reduce the effects of remarriage on the data. However, it is sometimes difficult to find out about the survival of a first spouse, especially if marital unions in the society are unstable or if polygamy is widespread.

Questions on survival of CEB and on orphanhood should relate to "own children" (children actually borne by the woman) and to biological parents. Adopted children and foster parents pose particularly difficult problems in many countries. Errors can best be forestalled by wording the questions in ways to make it clear that the relationships refer to the own-children and own-parents, for whom suitable terms exist in most languages.

4.4.7 Adjusting Data to Correct for Errors

Because of these different types and magnitudes of error which can affect fertility and mortality data and the resulting estimates, it is generally important to evaluate the data, and adjust them if necessary and possible. The evaluation techniques, which often also offer a basis for adjustment if the results are sufficiently coherent, generally take the form of consistency checks, either internally with other information collected by the same survey, or externally with information available from other sources. Typical errors that need to be tested for are omission of children ever born or children dead from reports of older women, or misdating events, or misreporting of age, or straightforward omission of events. A battery of indirect evaluation and adjustment techniques has been developed over the last 20 years, and has greatly increased the usefulness of flawed survey data. Many of these techniques are described and illustrated in another report of the Committee (Hill et al., 1981).

It must be emphasized that adjustments should be made only with great care. The adjustment procedures generally take the form of forcing into consistency two related but not identical types of information, and such adjustments are dangerous because both types may be flawed, raising the possibility of consistent but wrong estimates. It is generally the case that major problems with an adjustment procedure cause unacceptable results by age, or some other warning flag that all is not well, but this is not necessarily the case, and results obtained after adjustment involve a measure of uncertainty not found in results obtained from reliable data. In the case of most surveys from developing countries, however, the data should not be accepted at face value, and consistency checks should be applied to evaluate their quality prior to drawing firm conclusions. The uncertainty introduced by adjustment also implies that small differences between adjusted measures should be interpreted with great caution.

4.4.8 Other Important Considerations in Surveys

The checklist in Figure 4.1 presents several other major decisions that face planners who choose the survey method to collect fertility and mortality information. Various advantages and disadvantages are associated with each choice. For example, deciding to use a form instead of a questionnaire (item G.1 in Figure 4.1; see also footnote a in Figure 4.1 for the definitions of "form" and "questionnaire") allows more information to be recorded in a smaller space, which is sometimes desirable, particularly in multi-round household surveys in which the number of questions must be limited. However, much greater precision of understanding between interviewer and respondent can be attained when a questionnaire is used, that is, when each question is listed exactly as the interviewer is required to ask it. Understanding is also improved when the questionnaire is translated into local languages and when field workers are carefully trained to make certain that both interviewers and their supervisors know how to cope with questionnaire complexities. In the World Fertility Survey, the average length of field worker training has been three weeks. Tape recordings of practice interviewing sessions are reviewed by senior staff to allow them to criticize and correct faulty procedures before workers are sent into the field. Both translation and training naturally require additional resources, including senior staff time and money.

The sample design should take careful account of the principal characteristics of field operations (O'Muircheartaigh, 1977): (1) the type of interviewer; (2) the number of interviewers available; (3) the number of visits to be made to each observational unit; (4) the length of the interview; (5) the number and mobility of supervisors; (6) the mode(s) of travel; and (7) the quality of communication between field headquarters and the field staff.

In addition to attention to field work details--such as quality control, design of field operations and schedules, and training of field workers--the survey method also requires attention to data processing. This must occur early on in the design process, with programming being initiated as soon as the final design and content of the questionnaire has been determined. A major defect of many surveys is the lack of early attention to data processing, tabulation plans, and the assignment of staff adequate to analyze the data and prepare reports of survey findings. The design, preparation, field implementation, coding and editing, tabulation, analysis of data, and report of findings for a survey all add up to a major, difficult, and time-consuming set of activities.

4.5 ADVANTAGES AND DISADVANTAGES OF THE FOUR TYPES OF SURVEYS

The four major types of surveys described earlier in this chapter--single-round demographic surveys, multi-round surveys, dual-record systems, and fertility surveys--have different features and consequently different advantages and disadvantages in measuring fertility and mortality. The sections that follow discuss the relative strengths of each type of survey.

4.5.1 Single-Round Surveys

Perhaps the major reason why single-round retrospective household surveys are used so frequently to obtain demographic data is that they can be done more easily on an ad hoc basis than repeated-visit surveys. Moreover, even when a separate survey is conducted strictly to collect demographic data, but especially in the case where demographic questions are simply added to an existing or planned survey, single-round surveys are cheaper than repeated-visit surveys of the same quality (that is, those that are similar in terms of interviewer training, supervision, field control, etc.). Also, rotation bias and respondent fatigue from repeated interviews present no problems in a single-round survey.

There is no general agreement about how useful single-round survey results are for generating estimates of vital statistics. Some argue for basing fertility and mortality estimates on single-round surveys with CEB summary questions (Brass, 1973) or orphanhood questions

(Blacker, 1977a) or a set of several fertility and mortality questions (Sullivan et al., 1980), and adjusting the data with indirect estimation procedures. Such arguments are based primarily on the rationale that developing countries cannot afford the more costly survey systems. Others (Krotki, 1978b; Seltzer, 1973; Marks et al., 1974; Wells and Horvitz, 1978) have argued for the built-in calibration features and long-range benefits of dual-record systems, or emphasize the advantages of using improved collection procedures in the context of multi-round surveys (ORSTOM-INSEE-INED, 1971).

An example of a widely used type of single-round survey is the Intercensal Population Survey (SUPAS) conducted in 1976 in Indonesia. The SUPAS served as a link between the 1971 and 1980 censuses, although it collected more information than is normally collected in a population census. The SUPAS was designed to achieve the following objectives: (a) to obtain detailed socioeconomic data for interregional comparisons, (b) to help estimate population trends in Indonesia, (c) to provide estimates of the labor force and information about manpower conditions and utilization, (d) to determine the validity of other sources of fertility and mortality estimates, (e) to provide several measures to assess the extent of family planning utilization, and (f) to participate in the World Fertility Survey.

The SUPAS was conducted in three integrated, multipurpose phases. Phase I involved a large household listing, for which selected information was collected on all members of the household, including name, family relationship, sex, age, marital status, and own-mother status. Phase II collected more detailed information from a subsample of selected respondents. This was the most comprehensive phase of the undertaking; topics covered included individual characteristics of household members, martial and divorce history, own children, desire for additional children, contraceptive knowledge and practice, religion, education, household composition, income, work status and conditions, population movement, and fertility. Phases I and II were both single-round surveys. Phase III, conducted in connection with the Indonesian family planning program, was a fertility survey carried out in conjunction with the World Fertility Survey.

4.5.2 Multi-Round Surveys

One advantage of the multi-round survey over the single-round is that repetition of visits to the same dwelling offers the opportunity to verify data recorded on previous visits, thus improving their quality. Although the initial round is conducted primarily to establish the base population to be used for follow-up, this interview or any of the follow-up interviews can be used to collect the same kind of data that would be collected in a single-round survey. Even when no analysis is to be done of data collected in the initial round, the recording of events that occurred prior to the baseline provides information that can be used to guard against forward telescoping of events into the reference period at the time of the first follow-up visit. Utilizing the principle of bounded recall at each follow-up visit--that is, asking specifically about events that occurred since the previous visit--can reduce errors of dating and erroneous inclusions. Utilizing the follow-up or household-change technique can reduce errors of omission, especially for deaths of persons who were listed in a previous round. In-migrants and children who are born but subsequently die between rounds or migrate before the follow-up visit present special problems that must be dealt with primarily through careful probing by the interviewers and updating of household lists. Clear counting rules must be applied to obtain the best agreement between numerator and denominator of vital rates being estimated; usually, events that occur to the de jure population are the events of interest.

An extensive literature exists on the use of multi-round surveys. Cantrelle (1974) describes the evolution of the approach in Francophone Africa and refers to the early efforts of Kannisto (1959, 1963) in Cambodia and Indonesia as well as efforts in Latin America by CELADE, the Latin American Demographic Center. During the 1960s, the Economic Commission for Africa (ECA) was improving methodology on the basis of African experience, which led to procedures used in surveys in Senegal (1970-71) and Lesotho (1971-73), and the development of a manual on demographic sample surveys in Africa (UNECA, 1974). In this manual Scott and Blacker discuss the merits and problems of both multi-round and dual-record systems in Africa. Somoza (1976) and Hill et al. (1977) describe the CELADE efforts in detail.

In calculating vital rates from multi-round survey data, CELADE obtained the denominators of the rates (person-years of exposure) by finding the differences between the dates of previous follow-up visits and dates of current follow-up visits. Perhaps the more common approach is to calculate the average date of interview (weighted mid-date of all interviews) over all households in each round, find the difference between those, and adjust the numerator to correspond to a one-year time span.

Measurement of infant mortality and perhaps fertility may be improved if the pregnancy status of eligible women is established in each round and the outcome of the pregnancy determined in follow-up rounds. Pregnancy may be established by asking questions or by interviewer observation of late pregnancies, or both. An alternative approach would involve pregnancy testing, although there have been few careful field trials of this approach. One study in Thailand, which compared the results of pregnancy testing and pregnancy questions in a follow-up survey in which women were visited every six weeks, concluded that the results of pregnancy testing added little to the information about live births obtained by asking the questions (Udry et al., 1971). However, the tests did produce better information on fetal mortality. As the availability of maternal care spreads, it may become more feasible to cooperate with local health officials in the use of pregnancy rosters in demographic follow-up surveys.

Multi-round surveys are more costly than single-round surveys; whether they are more cost-effective in achieving lower mean square error in results is an open question. Based on the results of an experiment in which the fourth round of the Honduras multi-round survey (EDENH) was treated as a single-round survey (RETRO-EDENH), Hill et al. concluded (1977:160):

> . . . retrospective surveys like RETRO-EDENH are quick, easy to organise, cheap, and give good national estimates of fertility and mortality [when mortality is estimated using orphanhood techniques]; they can also give some indication of migration. Multi-round surveys of the EDENH variety are slower, more difficult to organise, more expensive, provide a mass of information about fertility, mortality, and migration, but are not altogether satisfactory for the estimation of

> mortality levels. The type of survey that should be adopted depends on the objectives, in terms of information, and the circumstances, in terms of money, skilled personnel, and organizational ability.

Multi-round surveys require clear procedures for identifying households for follow-up visits; finding the original household and making sure it is the same household is not always easy, especially if some time has elapsed and the interviewers have changed. In addition, it is essential that all households in the sample areas be interviewed, according to the recommended system of area sampling. Questionnaires used in multi-round surveys may also be more complex than those for a single round and the completed ones often must be made available for use in subsequent visits. Moreover, interviewers must be well-trained, motivated, and closely supervised to guard against their making false reports of "no change."

The longer duration of a multi-round survey usually requires the use of permanent field personnel and may result in respondent resistance if too many rounds are included. To cover seasonal variations, the minimum duration should be one year. CELADE recommends that no survey be spread over more than 18 months. It is difficult to maintain consistency in the repeated application of procedures over time, and the quality of field work may change from round to round. Presumably the interviewer work of the latter rounds should be of better quality because of increased experience, but that might be offset by respondent fatigue or, more likely, interviewer complacency or boredom.

4.5.3 Dual-Record Systems

There is not universal agreement about the advantages and disadvantages of dual-record systems, especially when they are compared with multi-round surveys. Cantrelle (1974) points out that while the multi-round system effectively reduces the risk of error, it does not allow for the potential measurement of coverage error. The dual-record system permits measurement of the coverage error in each subsystem, although not in the system as a whole. In Fellegi's words (1980): "It is incorrect to describe the dual method as containing a built-in

TABLE 4.6 Effect of Proxy Reporting on Estimates of Current Fertility: Colombia 1976 National Fertility Survey

	Proportions Reporting a Birth in Year Prior to the Survey					
	Women Reported in Both Surveys (Unweighted)					
	Proxy-Reported in Household Survey		Self-Reported in Household Survey		All Women Interviewed in Household Survey (Weighted)	
Age at Survey	Household Survey Report (Proxy)	Individual Survey Report (Self)	Household Survey Report (Self)	Individual Survey Report (Self)	Reported by Proxy	Reported by Self
15-19	.025	.025	.162	.144	.030	.158
20-24	.129	.128	.257	.265	.113	.284
25-29	.126	.129	.234	.244	.128	.230
30-34	.134	.147	.194	.199	.109	.189
35-39	.153	.133	.147	.143	.098	.145
40-44	.027	.057	.085	.089	.020	.069
45-49	.000	.001	.018	.021	.015	.022
Total Fertility Rate	2.970	3.100	5.485	5.525	2.565	5.485

Source: Hobcraft (1980:17, Table 2.2.)

self-evaluation, as some writers have claimed; in fact, one component of the method provides some evaluation of the other component, but there is no 'self-evaluation' of the final estimate." Dual systems do not eliminate all possibility of error, although the calibration feature of dual systems has improved estimates of fertility and mortality.

Dual-record systems aim for high levels of event coverage from both subsystems, and matching is an extremely important component of dual systems. In most dual-record systems, matching has been done by hand, which is slow, laborious, and subject to errors of human judgment. A system was developed in Kenya for computerized matching of the later rounds (Kenya, 1977), but this required a long time to develop and rules were based upon first-round results. Because the quality of recorded data may change over time, it probably is necessary to do some hand matching every round as a check. After initial matching, unmatched events and doubtful matches must be returned to the field for rechecking to determine whether they are in-scope events or not. Out-of-scope events must be eliminated in order not to overestimate rates.

Thus, the dual-record system has a number of potentials for higher costs than single-round or multi-round systems: (a) maintenance of the recorder subsystem in addition to the survey component; (b) additional care in field identification (for example, maps and field identification systems must be even more carefully maintained than for a multi-round survey to insure that the two subsystems are covering the same sample); (c) matching of vital events; and (d) field recheck of unmatched events. Some of these costs also occur in multi-round surveys that attempt dual measurement by matching events in overlapping reference periods. Matching of vital events appears to be the most formidable technical problem to be solved in dual-record systems and "dual measurement" multi-round surveys with overlapping reference periods.

If resources and qualified personnel are available and the choice lies between a multi-round and a dual-record system, many options are available. The average dual system has been more expensive than the average multi-round survey, however even if the multi-round survey costs less, it is not clear that it is cost-effective in terms of adjusting for biases of omission.

Many of the concerns noted in the section on multi-round surveys also apply to dual-record systems, because the survey subsystem almost always involves repeated rounds at intervals of 6 or 12 months. In addition, a crucial organizational and supervisory problem is to maintain independence between the subsystems (see Marks et al., 1974). A particular bias of dual systems is a tendency to overestimate the number of events, which can occur because of errors in matching or coverage errors in space or in time. This possibility exists because of the basic philosophy of the method: any report of an event is to be counted as true, even if unsubstantiated by the other system. However, in practice, dual systems usually include some field checks for unmatched events, to detect false nonmatches caused by coverage errors and overly strict application of matching criteria.

Marks et al. (1974) provide a substantial reference on the dual-record system, which is sometimes also known as the population growth estimation system. In addition, many publications of the POPLAB program are devoted to various facets of the dual-record system, and Carver (1976) has developed an extensive bibliography. One scholar has severely criticized the dual-record system as a means of estimating fertility and mortality (Blacker, 1977b), and additional discussion is found in Krotki (1978a and 1978b).

4.5.4 Fertility Surveys

By providing data on both current and past fertility, fertility surveys make it possible to estimate current levels of fertility as well as trends over a period up to 15 or 20 years prior to the survey. This information has distinct advantages, especially when there is a desire to analyze fertility trends in relation to social, familial, economic, and fertility-regulation contexts, for which data are often collected at the same time.

Every fertility survey must be based on a prior data collection operation that created a list of household members, which can then be used to identify women to interview. This prior operation may be planned either independently or specifically to identify women for the fertility survey, and it may be a single-round or multi-round survey, a dual-record system or a subsample of a larger demographic survey.

One example of how fertility surveys can be incorporated into a larger data-collection effort is the Algerian 1969-70 three-round survey, in which a fertility survey was included in one round in a subsample of women. An approach such as this offers several advantages: use of an existing sample with field operations already in place, the availability of detailed household information provided by the main survey, and an existing survey apparatus that includes commitment of office staff and data processing equipment.

However, whether conducted independently or attached to other surveys, fertility surveys have special requirements. Female interviewers are required in almost all situations, which usually means the creation of separate, independently-trained interview teams. In comparison with the other three types of surveys, the fertility-survey interview usually takes more time, up to an hour or more, and thus fewer can be completed each day and the cost per interview is substantial.

Another issue that affects the cost-benefit ratio of fertility surveys is whether a small number of interviewers is used for a long period or whether a larger number of interviewers is used, thereby shortening the duration of field work. The World Fertility Survey represents the largest and most recent program to use pregnancy histories. In 38 WFS surveys with sample sizes that ranged from about 3,000 to 9,000, the number of interviewers ranged from 19 in Venezuela and 20 in Senegal to 60 in Thailand, 80 in Nepal, and 144 in the Philippines (Scott and Singh, 1980). The duration of field work ranged from 2 to 8 months (plus 2 countries in which field work interruptions increased the time to 12 and 13 months). The advantages of a short period of field work include additional sources of recruitment (for example, the opportunity to employ teachers during vacation periods), reduced drop-out of field workers, and quicker access to the survey results--all of which represent substantial advantages to analysts and planning agencies. The advantages of a survey of longer duration with fewer interviewers include the potential for better supervision and the need for fewer vehicles.

Another important design issue concerns the schedule (form or questionnaire) used to obtain the pregnancy (or fertility) history. The initial model questionnaire developed by WFS suggested the use of two separate tables, one to record data on live births and the second for data on all other pregnancies. Some countries used this format in their studies, but several used other, integrated approaches, including: (a) to first list data on all live births, then question the respondent about each birth interval to probe for information about other, unreported pregnancies; (b) to ask separately about living children, dead children, stillbirths, miscarriages, and abortions, and then probe for additional information about each interval larger than a specified number of years; (c) to obtain data on each pregnancy in sequence (Scott and Singh, 1980:40).

The WFS experience suggests that integrated approaches, especially method (a), produce better results than the simpler two-table approach of the initial model. There is still uncertainty about whether it is better to attempt to reconstruct a woman's pregnancy or fertility history by starting with first pregnancy and working forward to the present or by starting with the most recent and working backward in time. In either case, though, it is important for interviewers to review the history carefully and to probe for unreported pregnancies when an especially long interpregnancy interval appears.

In addition to questions of schedule design and field procedures, other topics that require attention include training, supervision in the field and during data processing, how to collect the dates of events (especially dating of events in the pregnancy history), the ways to collect data on marital history and use of contraception, and how to handle nonresponse (answers of "don't know" or "not sure"). Detailed descriptions of these and other survey design and implementation procedures are found in the WFS Basic Documentation Series and the U.S. Bureau of the Census Popstan series.

Much of the data collected in early fertility surveys remained unanalyzed, and in some cases only summary tabulations have been prepared. Skilled analysts have been in short supply in many of the countries conducting fertility surveys, their services being in considerable demand, for example, for other surveys or for the next census. The World Fertility Survey has tried to resolve this problem by providing skilled technical analysts as short-term professional assistants and by commissioning model studies using selected data.

Although fertility surveys often produce both highly detailed and accurate data, the data are by no means immune to error and adjustments are usually necessary. Some of the errors are similar to those of other data-collection methods and other types of surveys, for example, age misreporting, omission of events, and incorrect dating of events. Frequently, respondents to fertility history interviews know neither the day nor month--sometimes not even the year--in which a birth occurred.

Obtaining reliable estimates from fertility survey data depends very heavily upon accurate reporting of dates of live birth and ages of surviving children. This is especially true when attempting to estimate time trends in fertility. Using simulation, Potter (1977) has developed a model that fits empirical data from El Salvador and Bangladesh. The model suggests that telescoping effects can be especially troublesome if not taken into account. When reporting births, women tend to overestimate the number of births that occurred during the period five to nine years ago, producing an upward bias in the fertility estimate of that period and a corresponding downward bias in the neighboring time periods. Thus, unadjusted fertility estimates based on such data can suggest a decline in fertility when none exists or a decline of larger magnitude than has in fact occurred.

Other evidence of bias in fertility history data can be seen in the 1975 Survey of Fertility in Thailand (SOFT), a WFS survey that collected retrospective birth histories and which reported total fertility rates of 6.25 for 1965-69 and 4.85 for 1970-74 (Thailand, Institute of Population Studies and National Statistical Office, 1977). In subsequent analysis (NRC, 1980:23), it was noted that "the proportions of women ever married by age indicated from the household schedules collected in the SOFT were substantially lower than the proportions of women ever married by age indicated by either the 1970 census or the 1975 Survey of Population Change. The latter two sources agree quite closely with each other, suggesting that the SOFT results are probably not representative." To compensate for this, the SOFT data were adjusted in two ways. One adjustment, necessary because of a slight bias in the sample of women in the fertility survey, was made by applying the 1970 census proportions of ever-married women, by age, to the SOFT marital fertility rates. This adjustment, plus another adjustment that had a smaller effect, produced revised estimates of the total fertility rate: 6.46 and 5.09, respectively, for the periods 1965-69 and 1970-74 (NRC, 1980). (Note that the estimated levels of fertility changed as a result of the adjustment, but the amount of decline remained essentially the same.)

Another example of apparent bias in fertility history data was discovered in WFS data from Nepal (Goldman et al., 1979). In that case, three types of response error were investigated: misreporting of age and marriage durations, displacement of vital events, and omission of vital events. Adjustments led to the following conclusion (1979:18): "Although the data as reported in the individual histories indicate that (1) fertility has been rising for the past 20 or 25 years, and (2) age at marriage has been subject to no consistent trend over this period, when errors in the reporting of vital events have been corrected, the demographic picture is more likely to show (1) no trend in fertility, and (2) rising age at marriage."

Another type of error to which fertility surveys are susceptible is the propensity for women over age 35 to report their living and deceased children less completely than younger women. Brass and Rashad (1980) discuss other problems on fertility history data that require attention and adjustments, and Brass (1980) summarizes the papers presented at a seminar on birth history analysis organized in 1980 by the International Union for the Scientific Study of Population.

4.6 HOW GOOD ARE SURVEY ESTIMATES?

Without knowledge of the true demographic rates in a population, it is difficult to assess how well a specific survey approach performs in measuring the rates. In the preceeding sections, examples of standard and special adjustments were noted; such adjustments improve the estimates, but they cannot produce absolute demographic truths. Likewise, experiments such as those in Kenya (Kenya, 1977), Peru (Marckwardt, 1973), and Colombia (CIMED, 1973; Hobcraft, 1980) can compare results obtained by different procedures but cannot determine with certainty which yields results closer to the true rates. Even these comparative experiments are subject to the criticism that they are special study situations and therefore interviewers, training, and supervision are likely to be of better quality than would be the case in a survey conducted under more usual conditions.

As part of a WFS program to evaluate the quality of the data collected in the WFS fertility surveys, O'Muircheartaigh and Marckwardt (1980) undertook an assessment of the reliability of survey data from selected countries. Their results demonstrated that means and other measures of distribution can appear quite stable (based on interview/reinterview analysis) while the underlying individual responses are very inconsistent. In Bangladesh, for example, the means of the current age distribution based on two different sets of interviews agree to the nearest tenth of a year (28.7), despite the fact that 80 percent of the women reported their age differently in the two interviews and 40 percent reported differently with respect to their five-year age group. Similarly, in the 1969-70 three-round survey in Algeria, the single-round retrospective survey seems to give the same birth rate as the multi-round survey (50 per thousand) and a lower death rate (13 per thousand instead of 17 per thousand). However, close examination of the retrospective-survey data used to estimate the birth rate reveals both under- and overreporting of births; thus, the retrospective estimate only appears correct, due to compensating effects (Vallin, 1975).

O'Muircheartaigh and Marckwardt also discovered large differences among countries in the reliability of demographic measures based on dates of events. For example, discrepancies of two or more years in the dating of first births occur in only 10 percent of the cases in Peru and Fiji, while in Indonesia and Bangladesh approximately one third of the women gave responses that were discrepant by two or more years (O'Muircheartaigh and Marckwardt, 1980:43). In one country they found reports of age at marriage to be substantially better than those of current age; in other countries, the reverse was true.

In an analysis of surveys that were part of 18 dual-record systems operated in Asia from 1945 to 1967, Marks et al. (1974) showed that on average multiple-visit surveys missed fewer events than single-visit surveys, when compared with the overall estimates obtained from the dual-record systems. The results of the comparison, shown in Table 4.7, demonstrate the degree of underreporting that can occur in surveys, especially single-round surveys. Note that in both types of surveys reporting of deaths tends to be less complete than that of births. The low coverage obtained in some of the multiple-visit surveys is almost certainly due in part to the practice of treating each visit as an independent survey, rather than using the household-change technique, which began to be used more widely in multi-round surveys in the 1960s. It should be noted that the standard used

TABLE 4.7 Estimated Average Completeness of Birth and Death Rates Reported in Surveys in Asia 1945-67: Estimates from Selected Single-Round Surveys and Repeated Single-Round Surveys[a] Compared to Dual-Record System Estimates

	Ratio of Completeness Relative to Estimates from Dual-Record System				
		Births		Deaths	
Type of Survey	Number of Surveys	Median	Range	Median	Range
Single-round	5	.67	.53-.93	.51	.32-.90
Repeated single-round	13	.83	.66-.92	.72	.50-.89

[a] In the source document for this table these surveys are referred to as "multiple-visit" surveys. Most of these surveys are similar to the type referred to in this report as "repeated single-round surveys." The latter should not be confused with multi-round surveys. (See definitions section in Chapter 4.)

Source: Based on Marks et al. (1974: Table 2.10). (One very low-reporting survey was considered an unrepresentative outlier and was not included in this table.)

in this analysis (estimates from the dual-record systems) could have an upward bias, for example, as a result of matching errors (false non-matches). Thus several surveys, especially the multiple-visit surveys, may have produced better reporting than is indicated in Table 4.7.

Another comparison of single-round vs. multi-round survey data is provided by Senegal's 1970-71 demographic survey. Table 4.8 compares the birth and death rates estimated for the 12 months before the baseline survey (based on data from the first round) with those estimated for the 12-month period after the baseline survey (based on data obtained through two follow-up visits). Overall, the estimates from the single-round baseline survey are 22 percent lower for births and 32 percent lower for deaths than the multi-round survey results for the following 12 months. In addition to overall lower reporting of deaths than births by the single-round retrospective survey, there is greater variation in death reporting by region; the ratios of retrospective to multi-round estimates range from 0.51 to 1.01 for deaths and from 0.65 to 0.94 for births.

Similar to the Senegal example but somewhat more informative are the results of an experiment in Kenya, which permit comparison of CBRs and CDRs that are based on both actual and reconstructed data collection methods. The Kenya project (Kenya, 1977) was a methodological experiment that compared the following methods: a continuous surveillance survey, single-round retrospective surveys with 6- and 12-month recall periods, multi-round surveys with 6- and 12-month recall periods, and a community contact system. Table 4.9 presents CBR and CDR estimates based on the first two methods, plus various combinations of methods used to produce dual-system estimates. In addition, the table presents estimates based on the 1973 single-round baseline survey (Kenya, 1975) and estimates based on application of indirect estimation techniques.

Under the continuous surveillance system a full-time enumerator visited each household every two months to collect information on births, deaths, and migration. In effect, the enumerator updated the household roster for each household. Four single-round retrospective surveys were carried out, using both 6-month and 12-month recall periods. These surveys were independent, listing the household members anew at each visit, instead of updating a previous household roster. Although the surveys were part of a large experiment, the individual estimates can be studied, including comparison based on whether out-of-scope events are included or eliminated. Inclusion of out-of-scope events naturally affects the quality of estimates obtained.

Note in Table 4.9 the ranges of the CBR and CDR estimates: 39 to 57 for the CBR and 5 to 13 for the CDR. The indirect estimates from the single-round baseline survey agree with the dual-system estimates obtained after stratification by age and urban/rural residence when the latter use a 6-month recall period. However, the dual-system estimates for the CBR using 12-month recall periods (57, both with and without stratification) are higher than all other estimates. The rates based on data derived from only one system, either the single-round retrospective survey or the continuous surveillance, are substantially lower than the other

TABLE 4.8. Comparison of Crude Birth and Death Rates Estimated from Baseline Retrospective Survey and from Subsequent Rounds: Senegal 1970-71, Demographic Survey

	Source of Data					
	Retrospective Baseline Survey (First Round)		Multi-Round Follow-Up Survey (Rounds 2 and 3)			
	Crude Vital Rates for 12 Months Prior to Round 1		Crude Vital Rates for 12 Months Between Rounds Rounds 1 and 3		Ratio of Estimates (Retrospective/Multi-Round)	
Region	Births	Deaths	Births	Deaths	Births	Deaths
Cap-Vert	39.8	5.1	42.3	9.0	0.94	0.57
Casamance	33.2	12.8	37.4	25.2	0.89	0.51
Diourbol	34.0	21.0	49.0	24.0	0.69	0.88
Fleuve	33.6	11.7	37.1	11.6	0.91	1.01
Sen. Orient.	36.0	15.4	39.5	24.0	0.91	0.64
Sin. Saloum	36.5	16.3	56.5	24.6	0.65	0.66
Thies	36.0	15.0	49.0	22.0	0.73	0.68
Total	35.9	13.9	45.9	20.3	0.78	0.68

Source: Republique du Senegal, Enquete Demographique National 1970-1971--Methodologie et Documents Annexes, Ministere des Finances et des Affaires Economiques, Direction de la Statistique, Dakar (May 1973, p. 6.)

TABLE 4.9 Comparisons of CBR and CDR Estimates Based on Selected Data Collection Methods: Kenya

			Estimated Vital Rates	
Data Source	Basis of Estimate	Recall Period	Crude Birth Rate	Crude Death Rate
Reconstructed and Actual Estimates from 1974-75 Dual-Record System				
Reconstructed single system (including out-of-scope events)	Retrospective Survey	6 months	45	7
		12 months	42	5
	Continuous Surveillance	Visits every 2 months to update household roster	41	8
Reconstructed single system (excluding out-of-scope events)	Retrospective Survey	6 months	41	6
		12 months	39	5
	Continuous Surveillance	Visits every 2 months to update household roster	40	7

estimates. This is especially true for the CDR; CDR estimates from reconstructed single systems after adjustment for out-of-scope events are about half those from dual systems and indirect estimation techniques (5 and 7 as compared to 11 and 13). Even when "extra" out-of-scope events are included, estimates from the reconstructed single system are still lower than those obtained with the dual-system approach, much lower in the case of CDR.

4.7 THE EXTENT TO WHICH SURVEYS ARE USED IN ESTIMATING FERTILITY AND MORTALITY

Surveys have been used extensively during the past two decades to collect fertility and mortality data. Table 4.10 shows the number of major demographic and fertility surveys carried out in developing nations since 1960. The demographic surveys counted included single-round, multi-round, and dual-record surveys; all collected fertility data and nearly all collected at least some mortality data.

In creating the list, the attempt was made to include only national and major sub-national demographic and fertility surveys. Also included are a few surveys in which the main topics of interest were non-demographic but which provided demographic data because fertility and mortality questions were asked. A number of judgments were required in determining whether or not a given non-national survey was "major." In general, the category included surveys that were representative of all urban areas or all rural areas in a country and surveys that covered a major part of a country (for example, Maharastra State in India). Most follow-up surveys of family-planning acceptors were not included, because their samples are representative only of acceptors, not total populations; exceptions were contraceptive prevalence surveys that collected household information from samples of general populations, because such surveys include questions on fertility. For example, some of the prevalence surveys conducted with the help of Westinghouse Health Systems and the Centers for Disease Control ask representative samples of ever-married women or all women under age 50 for number of pregnancies, number of live births, number of living children, and date of last live birth. Table 4.11, which is the basis of the summary numbers in Table 4.10, presents a detailed accounting of surveys conducted in developing nations since 1960.

Table 4.10 lists surveys by two time periods: the 1960s and 1970-80. For the latter period, the WFS surveys are listed separately, to emphasize the major role the WFS program has played in the collection of fertility and child mortality data since 1974. Surveys that cut across the two time periods are listed in the decade that includes the larger number of survey years; footnotes indicate when arbitrary classification was necessary (for example, in the case of a survey conducted in 1969 and 1970).

Since 1960, 81 developing countries have conducted at least one major survey: 33 countries in Africa, 24 in Asia, and 24 in Latin America. In the 1960s, 37 national demographic and 19 national fertility surveys were carried out in developing nations; in the 1970s the numbers increased to 55 and 82, respectively. More than half the 82 fertility surveys (42) were conducted as part of or in association with the WFS program.

Although the numbers in Table 4.10 present an impressive picture regarding the use of surveys to collect demographic data, users interested in obtaining detailed information from these surveys frequently discover that much of the collected information has yet to be reported and that there are substantial delays between field work and the publication of results.

One example of the time delays in selected dual-system surveys and other estimation procedures is provided by Marks et al. (1974) and reproduced here as Part A of Table 4.12. In the eight dual-system studies conducted in developing nations the range was 11 to 76 months, but if the time considered is from the beginning of field work to publication of the final report, the range was 23 to 90 months. For the five single-round surveys (identified as "single system procedures"), the time lags between completion of field work and publication of final report ranged from 13 to 72 months.

The World Fertility Survey has placed high priority on improving the timing and the availability of its survey results. Among the 42 WFS surveys initiated in developing nations since 1974, at a rate of about 7 per year, detailed first reports by 23 countries had been published by the end of 1980. (See Part B of Table 4.12.) In addition, the number of publications generated by subsequent cross-national comparative research and research within individual countries is considerable; for example, a total of 34 research papers were presented at the World Fertility Survey conference in July 1980.

4.8 SUMMARY

Surveys constitute an important data collection technique for the measurement of demographic phenomena. The information in this chapter leads to five summary points:

1. Surveys have been used around the world to collect detailed information for the estimation and understanding of fertility and mortality. Surveys will continue to be used to provide basic data in the absence of complete CR/VS systems, and they will provide data sets that permit analysis of factors affecting fertility and mortality.
2. Each of the four major types of surveys has advantanges and disadvantages. The single-round survey probably yields the least accurate data in general, but

TABLE 4.11 Number of Major Demographic and Fertility Surveys Carried out in Developing Nations Since Approximately 1960, Classified by Time Periods 1960-69 and 1970-80

	1960-69				1970-80				
	Sub-National		National		Sub-National		National		
Area, Nation	Demographic	Fertility	Demographic	Fertility	Demographic	Fertility	Demographic	WFS	Other Fertility
Africa									
Algeria			1	1			1[a]		
Benin (Dahomey)			1					1	
Burundi			1				1		
Cameroon	2		1[b]				1	1	
Central African Republic							1		
Chad	1					1			
Congo	1				1				
Egypt	1		1		1			1	1
Ethiopia	1		1[a]			1			
Gabon	1		1		1				
Ghana		1	3[c]	1			1[c]	1	
Ivory Coast	1							1	

Area, Nation	1960-69 Sub-National Demo-graphic	1960-69 Sub-National Fert-ility	1960-69 National Demo-graphic	1960-69 National Fert-ility	1970-80 Sub-National Demo-graphic	1970-80 Sub-National Fert-ility	1970-80 National Demo-graphic	1970-80 National WFS	1970-80 National Other Fert-ility
Kenya			1		1		1	1	
Lesotho		1					1	1	
Liberia							1^{a}		
Madagascar (Malagasy Republic)			1						
Malawi							1		
Mali			1						
Mauritania	1							1	
Morocco			1	1^{b}	1			1	
Niger	1					1			
Nigeria	2^{c}	1				2^{a}	1		1
Rwanda							1		
Senegal	1		1			1	1	1	
Sierra Leone				1^{a}	1^{c}		1		
Sudan	1							1^{d}	
Tanzania							1		
Togo			1				1		1^{a}
Tunisia		1	1	1		1^{e}		1	
Uganda			1		1^{c}				
Upper Volta	1	1					2		
Zaire	1								
Zambia	$1^{a,c}$						1		1
Total	17	4	19	4	6	8	18	12	4
Asia									
Afghanistan					1		1		
Bangladesh	1^{c}	1	1				1	1	1^{e}
Brunei			1						
Hong Kong				1				1^{f}	1
India		2	2		2	3	3		1
Indonesia		1	2			3^{g}	3	1^{d}	
Iran		2					2	1	1
Iraq							1		
Jordan								1	1
Korea (South)			1	5			4	1	$6^{e,g}$
Lebanon									2
Malaysia	1	1			1	2		1^{d}	
Nepal	1						3	1	
Pakistan			3				2	1	
Philippines			3^{c}	1	1	1	2	1	2^{g}
Saudi Arabia							1		
Singapore									3^{g}
Sri Lanka		1	1^{a}					1	1
Syria					1			1	
Taiwan		1	1	2					2^{g}
Thailand		2	1			3	$2^{a,c}$	1	$2^{e,g}$
Turkey			1	2			2	1	1^{g}
Vietnam (South)						1			
Yemen Arab Republic					1		1	1	
Total	3	11	17	11	7	13	28	15	24
Latin America									
Argentina		2							
Barbados				1					1
Bolivia		1				1	1		
Brazil	1	1				2^{e}	1		

TABLE 4.11 (continued)

	1960-69				1970-80				
	Sub-National		National		Sub-National		National		
Area, Nation	Demo-graphic	Fert-ility	Demo-graphic	Fert-ility	Demo-graphic	Fert-ility	Demo-graphic	WFS	Other Fert-ility
Chile						1[a]			
Colombia		1		1	2	1		1	1[e]
Costa Rica		2						1	1[e]
Dominican Republic							1	1	
Ecuador		2						1	
El Salvador									2[e]
Guatemala		1				1			1[e]
Guyana								1	
Haiti							1	1	
Honduras							2		
Jamaica							1	1	1
Martinique/ Guadeloupe				1				1[f]	
Mexico		2						1	2[e]
Nicaragua		1				1			
Panama		2	1					1	1[e]
Paraguay					1	1		1	1[e]
Peru		2				1	1	1	
Puerto Rico				1					
Trinidad/ Tobago								1	1
Venezuela		1				2		1	
Total	1	18	1	4	3	11	8	14	12

---

[a] Survey overlaps the 1960-1969 and 1970-1980 time periods:

Algeria	1969-1971	Togo	1969-1970
Ethiopia	1968-1970	Zambia	1969-1970
Liberia	1969-1973	Sri Lanka	1969-1970
Nigeria	1969-1973	Thailand	1969-1973
Sierra Leone	1969-1970	Chile	1969-1970

[b] Multiple surveys combined to produce national coverage:

Cameroon	1960-1965	Morocco	1966-1967

[c] Survey classified in WFS Occasional Papers (Baum et al., 1974 a-d) as both demographic and fertility; listed once here under first classification, demographic.

[d] WFS Survey is sub-national:
Sudan - North only
Indonesia - Java and Bali only
Malaysia - West Malaysia only

[e] Contraceptive prevalence surveys; fertility questions include: number of pregnancies, number of live births, number of living children and date of last live birth. The contraceptive prevalence surveys such as those conducted with the assistance of Westinghouse Health Systems and the Centers for Disease Control generally do not include birth histories but they are included in this listing of fertility surveys since they are being used in the analysis of fertility. (One or more contraceptive prevalence surveys per country.)

[f] Associate status with WFS.

[g] Value of Children (VOC) Survey, interviews only with currently married women and their husbands. (One VOC survey per country.)

Sources:

Baum et al. (1974 a-d)
Bulatao (1979, Table 3)
World Fertility Survey (1980)
Centers for Disease Control
Roper Public Opinion Research Center
Westinghouse Health Systems
United Nations Economic and Social Commission for Asia and the Pacific (1980)

it is flexible and the easiest to organize. Multi-round surveys and dual-record systems provide more accurate estimates, but they are more costly, because of the need for multiple visits and, in the case of dual systems, matching procedures. Fertility surveys are the only type that provide the data required to measure fertility trends in the recent past. No one type is best in all situations.

3. Statisticians and subject-matter specialists charged with designing and implementing surveys and the policy makers and administrators to whom they report face many major and minor choices and a wide variety of options. Many of these choices concern sampling. Successful survey operations demand that careful attention be given to the implications of each choice made. Also, attention to all sorts of details is crucial in both the design and execution of surveys. Relatively small numbers of persons are interviewed in surveys compared with the number of people interviewed and events recorded in censuses and CR/VS systems; therefore, it is both possible and necessary to devote more careful attention to quality control, supervision, and potential sources of bias. Furthermore, surveys are not conducted frequently in most countries (usually there is a period of several years between surveys); thus, a poorly conducted survey can cause a major gap in information.

4. Surveys in developing nations have added quantity and quality to the stock of knowledge about fertility and mortality. However, they do not provide absolute truths about demographic phenomena, and it is appropriate to look for potential errors when analyzing survey data on fertility and mortality. Also, as with census and CR/VS data, the use of indirect estimation techniques can improve the estimates constructed from survey data.

5. The results of the largest fertility survey program (and probably the largest social science research project) ever attempted, the World Fertility Survey program, are becoming available. They constitute a major source of data for estimating fertility and child mortality levels in the 1970s, for estimating fertility trends since about 1960, and for understanding the processes involved in fertility change.

Dual-system estimates based on retrospective survey and continuous surveillance system (latter with visits every 2 months)	Two systems, without stratification	6 months 12 months	52 57	11 12
	Two systems, with stratification by age and urban-rural residence	6 months 12 months	52 57	13 13
Baseline Survey, 1973	Question on date of last live birth	[a]	49	[b]
	Application of indirect estimation techniques[c]	--	52[d]	13[e]

---

[a] Data on births during last 12 months extracted from information on data of last live birth.

[b] No question on "data in the previous 12 months" was asked.

[c] Estimates derived from one half of sample household only.

[d] Using the Brass P(1+)/F(1) technique with several adjustments for non-response.

[e] Using Brass and Sullivan techniques to estimate childhood mortality and the orphanhood technique to estimate adult mortality.

Sources: Kenya (1975:48, 50).
Kenya (1977:26, 28, Tables 3.3 and 3.4; and 68-69, Appendixes F and G).

TABLE 4.10 Number of Major Demographic and Fertility Surveys Carried Out Since Approximately 1960, Classified by Region and Decade

	1960-1969				1970-1980				
	Sub-National		National		Sub-National		National		
	Demographic	Fertility	Demographic	Fertility	Demographic	Fertility	Demographic	WFS	Other Fertility
Africa	17[a,c]	4	19[a,b,c]	4[a,b]	6[c]	8[a,e]	18[a,c]	12[d]	4[a]
Asia (excluding Japan and Israel	3[c]	11	17[a,c]	11	7	13[g]	28[a,c]	15[d,f]	24[e,g]
Latin America	1	18	1	4	3	11[a,e]	8	14[f]	12[e]
Oceania (excluding Australia and New Zealand	--	--	--	--	--	--	1	1	--
Subtotal	21	33	37	19	16	32	55	42	40
Europe	--	--	2	4	--	1[f]	3	1	25[f]
Other Developed	--	1	--	4	--	2	2	--	11[f,g]
Total	21	34	39	27	16	35	60	43	76

Note: For details on all footnotes, refer to Table 4.11. The order of footnotes in Table 4.11 is used here for consistency.

[a] Includes survey(s) overlapping the 1960-69 and 1970-80 time periods.

[b] Includes multiple survey(s) combined to produce national coverage.

[c] Includes survey(s) classified in WFS Occasional Papers (Baum et al., 1974 a-d) as both demographic and fertility; counted once here under the demographic classification.

[d] One WFS survey in Africa and two in Asia are sub-national.

[e] Contraceptive prevalence surveys such as those conducted with the assistance of Westinghouse Health Systems and the Center for Disease Control generally do not include birth histories but are included in the listing of fertility surveys since they are being used in the analysis of fertility.

[f] Includes two surveys in Associate status with WFS (1 in Asia, 1 in Latin America). In addition, 17 surveys in Europe (16 national and one sub-national) and three in other developed nations have been carried out in collaboration with the WFS Program.

[g] Includes 7 Value of Children (VOC) Surveys in Asia (6 national and one sub-national), one in Europe, and one in Other Developed. Interviews were conducted only with currently married women and their husbands.

Source: Table 4.11.

TABLE 4.12 Measures of the Time Lag Between Field Work and the Publication of Results, for Specified Dual-System Studies and Other Measurement Procedures

Part A. Population Growth Estimation and Other Studies

Country	Study and Reference Period	Date Field Work Began (1)	Date Field Work Ended[a] (2)	Date of Preliminary or First Report[b] (3)	Date of Final Report (4)	Elapsed Time in Months			
						(1) to (3)	(2) to (3)	(2) to (4)	(1) to (4)
Dual System Studies:									
United States	Birth Registration Test, 1940	Dec. 1939	Apr. 1940	Apr. 1943	Aug. 1946	40	36	76	80
United States	Birth Registration Test, 1950	Jan. 1950	Apr. 1950	Dec. 1952	Sept. 1954	35	32	53	56
United States	Birth Registration Test, 1964-68	June 1969[c]	Mar. 1970	Apr. 1971	u	22	13	u	u
India	Singur Health Center Study, 1945-46	Feb. 1947	Apr. 1947	u	Mar. 1949	u	u	23	25
Pakistan	Population Growth Estimation Study, 1962	Jan. 1963	Mar. 1963	Dec. 1964	Dec. 1968	35	21	69	83
Pakistan	Population Growth Estimation Study, 1963	Jan. 1962	Mar. 1964	Sept. 1965	Dec. 1968	32	18	57	71
Pakistan	Population Growth Estimation Study, 1964	Jan. 1964	Mar. 1965	Mar. 1968	July 1971	50	36	76	90
Pakistan	Population Growth Estimation Study, 1965	Jan. 1965	Feb. 1966	Mar. 1968	July 1971	38	25	65	78
Thailand	Survey of Population Change, 1964-65	July 1964	June 1965	Aug. 1966	Mar. 1969	25	14	45	56
Turkey	Turkish Demographic Survey, 1966-68	May 1966	May 1968	Jan. 1969	1970[d]	32	8	25	49
Liberia	Population Growth Survey, 1969-70	Oct. 1969	Oct. 1970	Feb. 1971	Aug.-Oct. 1971[e]	16	4	11	23

REFERENCES

Adlakha, A., H. Booth, and J. W. Lingner (1977) Systems of Demographic Measurement: The Dual Record System: Sampling Design--POPLAB Experience. Scientific Report Series No. 30, International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Bailar, B. A., and C. M. Lanphier (1978) Development of Survey Methods to Assess Survey Practices. Washington, D.C.: American Statistical Association.

Baum, S., K. Dopkowski, W. G. Duncan, and P. Gardiner (1974a) The World Fertility Survey Inventory: Major Fertility and Related Surveys Conducted in Africa 1960-1973. World Fertility Survey Occasional Papers, No. 4. London: International Statistical Institute.

Baum, S., K. Dopkowski, W. G. Duncan, and P. Gardiner (1974b) The World Fertility Survey Inventory: Major Fertility and Related Surveys Conducted in Asia 1960-1973. World Fertility Survey Occasional Papers No., 4 London: International Statistical Institute.

Baum, S., K. Dopkowski, W. G. Duncan, and P. Gardiner (1974c) The World Fertility Survey Inventory: Major Fertility and Related Surveys Conducted in Europe, North America, and Australia 1960-1973. World Fertility Survey Occasional Papers, No., 6 London: International Statistical Institute.

Baum, S., K. Dopkowski, W. G. Duncan, and P. Gardner (1974d) The World Fertility Survey Inventory: Major Fertility and Related Surveys Conducted in Latin America 1960-1973. World Fertility Survey Occasional Papers No., 5 London: International Statistical Institute.

Bhattacharyya, A. K. (1977) Comparison of Field Cost in Multi-Subject and Uni-Subject Surveys--A Case Study. Presented at the 41st Session of the International Statistical Institute, New Delhi, India.

Blacker, J. G. C. (1977a) The estimation of adult mortality in Africa from data on orphanhood. Population Studies 31(1):107-128.

Blacker, J. G. C. (1977b) Dual record demographic surveys: a re-assessment (a review article). Population Studies 31(3):585-597.

Booth, H., and Lingner, J. W. (1975) Data Processing and Analysis in Demographic Surveys. Manual Series No. 6. International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Brass, W. (1973) A Critique of Methods for Estimating Population Growth in Countries with Limited Data. Reprint Series No. 4. International Program of Laboratories for Population Statistics, University of North Carolina at Chapel Hill.

Brass, W. (1980) Birth History Analysis. Methodology Session No. 3 of WFS Conference, July 1980. London: World Fertility Survey.

Brass, W., and H. Rashad (1980) Exploratory Demographic Analysis of Imperfect Maternity Histories to Determine Levels and Trends of Fertility. Paper for the Seminar on Analysis of Maternity Histories sponsored by the International Union for the Scientific Study of Population, the World Fertility Survey, and the London School of Hygiene and Tropical Medicine, London, April.

Bulatao, R. A. (1979) On the Nature of the Transition in the Value of Children. Current Studies on the Value of Children, Papers of the East-West Population Institute, No. 60-A. Honolulu: East-West Population Institute.

Cantrelle, P. (1974) La Methode de l'Observation Demographique Suivie par Enquete a Passages Repetes (OS/EPR). Scientific Report Series No. 14, International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Carver, J. S., ed. (1976) Systems of Demographic Measurement, The Dual Record System: Bibliography on the Dual Record System. International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Centers for Disease Control (1980) Personal communication, September.

Centro de Investigacion sobre Metodos de Estimacion Demografica (CIMED) (1973) Resumen Demografico de Colombia. Bogata, Colombia: Departamento Administrativo Nacional de Estadistica, Serie de Divulgacion No. 2.

Cochran, W. G. (1977) Sampling Techniques, 3rd. ed. New York: John Wiley and Sons.

Cooke, D. S. (1971) Mapping and House Numbering. Manual Series No. 1, International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Departement de demographie de l'universite Catholique de Louvain (1976) L'observation demographique dans les pays a statistiques deficientes. Liege: Ordina edition, 320 pp.

El-Badry, M. A. (1961) Failure of enumerators to make entries of zero: errors in recording childless cases in population censuses. Journal of the American Statistical Association 56, no. 296 (December):909-924.

Ewbank, D. C. (1981) Age Misreporting and Age-Selective Underenumeration: Sources, Patterns, and Consequences for Demographic Estimation. Committee on Population and Demography, Assembly of Behavioral and Social Sciences, National Research Council. Washington, D.C.: National Academy Press.

Felligi, I. (1980) Personal communication.

Goldman, N., A. J. Coale, and M. Weinstein (1979) The Quality of Data in the Nepal Fertility Survey. World Fertility Survey. World Fertility Survey Scientific Reports, No. 6. London: International Statistical Institute.

Hansen, M. H., W. N. Hurwitz, and Madow, W. G. (1953) Sample Survey Methods and Theory (Vol. I: Methods and Applications). New York: John Wiley and Sons, Inc.

Hill, K., H. Zlotnik, and J. Trussell (1981) Indirect Techniques for Demographic Estimation. Committee on Population and Demography, Assembly of Behavioral and Social Science, National Research Council, National Academy of Sciences. (To be published as manual X in the series of manuals of demographic analyses of the Population Division, United Nations.)

Hill, K. H., G. A. Maccio, A Packer, and J. L. Somoza (1977) National Demographic Survey of Honduras: Methodology, Results, Indirect Estimates. Santiago: Centro Latinoamericano de Demogratia (CELADE).

Hobcraft, J. N. (1980) Illustrative Analysis: Evaluating Fertility Levels and Trends in Colombia. World Fertility Survey Scientific Reports, No. 15. London: International Statistical Institute.

INED-INSEE-ORSTOM-SEAE (1973) Sources et analyze des donnes demographiques, application a l'Afrique d'expression francaise et a Madagascar. Premiere partie: Source des donnees. Paris, 416 pp. Deuxieme partie: ajustement des donnees imparfaites. Paris, 184 pp.

INED-INSEE-ORSTOM-SEAE (1974, 1975, 1976) Sources et analyze des donnes demographiques, application a l'Afrique d'expression francaise et a Madagascar. Troisieme partie: analyze des donnees
  I. Les donnees individuelles et collectives. Paris, 1975, 62 pp.
  II. Instruction et activite economique. Paris 1976, 120 pp and 475 pp.

III. Nuptialite et fecondite. Paris 1975, 117 pp.
IV. Mortalite. Paris 1976, 126 pp.
V. Migrations. Paris 1974, 52 pp.
VI. Perspectives demographiques. Paris 1975, 118 pp.

INSEE-INED (1967) Afrique noire, Madagascar, Comores: Demographie comparee. Paris: OGRST. Two volumes, 344 pp and 368 pp.

Kannisto, V. (1959) Enquete Demographique au Cambodge. Multigraph.

Kannisto, V. (1963) Population Increase in Indonesia. Djakarta: Statistical Research and Development Center, Central Bureau of Statistics.

Kenya, Ministry of Finance and Planning, Central Bureau of Statistics (1975) Demographic Baseline Survey Report, 1973. Nairobi: Central Bureau of Statistics. (Also available as POPLAB Reprint Series No. 17, University of North Carolina at Chapel Hill.)

Kenya, Ministry of Finance and Planning, Central Bureau of Statistics (1977) Demographic Surveys (1973-1976): Methodological Report. Nairobi: Central Bureau of Statistics.

Kenya, Ministry of Economic Planning and Development, Central Bureau of Statistics (1980) Kenya Fertility Survey 1977-78: First Report. Nairobi: Central Bureau of Statistics.

Kish, L. (1965) Survey Sampling. New York: John Wiley & Sons.

Kish, L. (1977) Robustness in Survey Sampling. Presented at the 41st Session of the International Statistical Institute, New Dehli, India.

Kish, L., R. M. Groves, and K. P. Krotki (1976) Sample Errors for Fertility. World Fertility Survey Occasional Papers No. 17. London: International Statistical Institute.

Krotki, K. J., ed. (1978a) Developments in Dual System Estimation of Population Size and Growth. Edmonton, Alberta: University of Alberta Press

Krotki, K. J. (1978b) The role of PGE/ERAD/ECP surveys among endeavors to secure improved demographic data. In K. J. Krotki, ed., Developments in Dual System Estimation of Population Size and Growth. Edmonton, Alberta: University of Alberta Press.

Madigan, F. C. (1973) The Mindanao Center for Population Studies: A Philippine POPLAB Report. Scientific Report Series No. 8. International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Madigan, F., and Herrin, A. (1973) Birth and Death Rates from Dual Records Project for January 1, 1972, to June 30, 1972. Report No. 9, unpublished. Mindanao Center for Population Studies, Xavier University, Cagayan de Oro City, Philippines.

Marckwardt, A. M. (1973) Evaluation of an experimental short interview form designed to collect fertility data: the case of Peru. Demography 10:639-657.

Marckwardt, A. M. (1975) The World Fertility Survey: its demographic and sociological content. Population Index 41:171-181.

Marks, E. S., W. Seltzer, and K. J. Krotki (1974) Population Growth Estimation: A Handbook of Vital Statistics Measurement. New York: The Population Council.

National Research Council (1980) Fertility and Mortality Changes in Thailand, 1950-1975. Panel on Thailand, Committee on Population and Demography, Assembly on Behavioral and Social Sciences. Washington, D.C.: National Academy of Sciences.

O'Muircheartaigh, C. A. (1977) Proximum Designs for Crude Sampling Frames. Presented at the 41st session of the International Statistical Institute, New Dehli, India.

O'Muircheartaigh, C. A., and A. M. Marckwardt (1980) An Assessment of the Reliability of WFS Data. Methodology Session No. 6 of WFS Conference, July 1980. London: World Fertility Survey.

ORSTOM-INSEE-INED (1971) Les enquetes demographiques a passages repetes. Application a l'Afrique d'expression francaise: methodologie. Paris: ORSTOM-INSEE-INED.

Piche V. L. (1974) Social Change, Family and Fertility in Sub-Saharan Africa: Theoretical and Methodological Appraisal. Ph.D. dissertation, Cornell University.

POPLAB Staff (1978) A Basic Questionnaire: Data Collection and Analyses in Sample Surveys. Manual Series No. 7. International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Potter, J. E. (1977) Problems in using birth-history analysis to estimate trends in fertility. Population Studies 31(2):335-364.

Republique Algerienne Democratique et Populaire, Secretariat D'Etat au Plan, Direction des Statistiques (1971) Etude statistique nationale de la population: presentation generale de l'enquete. Serie 1: Methodologie, Volume: No. 1. Algiers: Direction des Statistiques.

Roper Public Opinion Research Center (various issues) Newsletter. Williamstown, Mass.: Roper Public Opinion Research Center.

Roper Public Opinion Research Center (1976) An Overview. The Roper Public Opinion Research Center, Inc., Williamstown, Mass.

Sabagh, G., and C. Scott (1973) A Comparison of Different Survey Techniques for Obtaining Vital Data. Reprint Series No. 10. International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Scott, C. (1980) Practical Problems in Conducting Surveys on Living Standards. Mimeo.

Scott, C., and J. B. Coker (1971) Sample design in space and in time for vital rate surveys in Africa. International Population Conference, London, 1969 1:248-256. Liege, Belgium: International Union for the Scientific Study of Population.

Scott, C., and S. Singh (1980) Problems of Data Collection in the World Fertility Survey. Methodology Session No. 1 of WFS Conference, July. London: World Fertility Survey.

Scott, J., and E. Chanlett (1973) Planning the Research Interview. Manual Series No. 4. International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Seltzer, W. (1973) Demographic Data Collection: A Summary of Experience. New York: The Population Council.

Senegal, Republique du (1973) Enquete Demographique National 1970-1971--Methodologie et Documents Annexes. Dakar: Ministere des Finances et des Affaires Economiques, Direction de la Statistique.

Simmons, W. R. (1972) Operational Control of Sample Surveys. Manual Series No. 2. International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Sirken, M. G. (1972) Designing Forms for Demographic Surveys. Manual Series No. 3. International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Somoza, J. L. (1976) The CELADE Demographic Survey Method. Scientific Report Series No. 18A. (English translation of Scientific Report Series No. 18), International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Sullivan, J. M., A. L. Adlakha, R. E. Bilsborrow, and A. R. Cross (1980) Collection of Birth and Death Data: POPLAB Approaches. Mimeo. International Program of Laboratories for Population Statistics, Chapel Hill.

Tabutin, D. (1976) La mortalite infantile et juvenile en Algerie. Travaux et documents de l'INED. Paris: Presse Universitaire de France, 275 pp.

Thailand, Institute of Population Studies and National Statistical Office (1977) The Survey of Fertility in Thailand: Country Report (Vol. 1). Bangkok: Institute of Population Studies and National Statistical Office.

Tuygan, K., and T. Cavdar (1975) Comparison of self and proxy responses to questions related to children of ever-married women. Chapter VI in A. Adlakha, ed., Proceedings of the Seminar on the Design of the Turkish Demographic Survey, 20-22 February 1974, Ankara: Papers Presented. Scientific Report Series No. 17. International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Udry, J. R., K. Srisomang, R. Burnright, D. O. Cowgill, N. M. Morris, and Y. Charas (1971) Pregnancy testing as a fertility measurement technique: a preliminary report on field results. American Journal of Public Health 61(2):344-352.

United Nations (1961) The Mysore Population Study. U.N. Series No. ST/SOA/Series A/34. New York: United Nations.

United Nations (1964) Handbook of Household Surveys. A Practical Guide for Inquiries on Levels of Living. Studies in Methods. Series F, No. 10. New York.

United Nations, Department of Economic and Social Affairs (1970a) Variables and Questionnaire for Comparative Fertility Surveys. Population Studies No. 45. Prepared by the Commission on Comparative Studies of Fertility and Fertility Planning of the International Union for the Scientific Study of Population in collaboration with the United Nations Secretariat. ST/SOA/Series A/45. New York.

United Nations, Department of Economic and Social Affairs, Statistical Office of the U.N. (1970b) A Short Manual on Sampling, Vol. II. Computer Programmes for Sample Designs. Studies in Methods Series F. No. 9. New York.

United Nations (1971) Methodology of Demographic Sample Surveys. Report of the Interregional Workshop on

Methodology of Demographic Sample Surveys. Copenhagen, Denmark 24 September - 3 October 1969. New York. Statistical Papers, Series M, No. 51.

United Nations, Department of Economic and Social Affairs, Statistical Office of the U.N. (1972) A Short Manual on Sampling, Vol. I. Elements of Sample Survey Theory. Studies in Methods Series F. No. 9, Rev. 1. New York.

United Nations Economic Commission for Africa (1974) Manual on Demographic Sample Surveys in Africa. U.N. Serial No. E/CN.14/CAS.7/17/Rev.2. Bangkok: Economic and Social Commission for Asia and the Pacific.

United Nations Economic and Social Commission for Asia and the Pacific (1980) Review of Demographic Sample Surveys in Asia and the Pacific, 1970-79. Publication No. St/ESCAP/135. Bangkok: Economic and Social Commission for Asia and the Pacific.

U.S. Bureau of the Census (1979) Popstan: A Case Study for the 1980 Censuses of Population and Housing. Statistical Training Document, ISP-TR-4 (parts A-G). Washington, D.C.: U.S. Government Printing Office.

Vallin, J. (1975) La mortalite en Algerie. Population 30(6):1023-1046.

Verma, V. K. (1977) Sample Designs for the World Fertility Survey. Presented at the 41st Session of the International Statistical Institute, New Delhi, India.

Verma, V., C. Scott, and C. O'Muircheartaigh (1980) Sample designs and sampling errors for the World Fertility Survey. Journal of the Royal Statistical Society A(143):431-473.

Warwick, D. P., and C. A. Lininger, (1975) The Sample Survey: Theory and Practice. New York: McGraw-Hill Book Co.

Wells, H. B., and D. G. Horvitz (1978) The state of the art in dual systems for measuring population change. In K. J. Krotki, ed., Developments in Dual System Estimation of Population Size and Growth. Edmonton, Alberta: University of Alberta Press.

Westinghouse Health Systems (1980) Personal communication, September 22.

World Fertility Survey (1975) World Fertility Survey: Core Questionnaires.
(1975) Survey Organization Manual.
(1975) Manual on Sample Design.
(1975) Supervisors' Instructions.
(1975) Interviewers' Instructions. London: International Statistical Institute, World Fertility Survey.

World Fertility Survey (1976) Training Manual. (1976) Editing and Coding Manual. London: International Statistical Institute, World Fertility Survey.

World Fertility Survey (1977) Guidelines for Country Report No. 1. London: International Statistical Institute, World Fertility Survey.

World Fertility Survey (1980) The World Fertility Survey: January 1979-December 1979 (WFS Annual Report). London: International Statistical Institute.

Single System Procedures:

United States	Civil Registration System, 1968	Jan. 1968	Dec. 1968	Mar. 1969	Jan. 1970	14	3	13	24
Pakistan	Intercensal Growth Rate, 1951-61	Feb. 1951	Feb. 1961	Mar. 1961	June 1964	121	1	40	160
India	National Sample Survey, 1960-61	July 1960	June 1961	Apr. 1963- Feb. 1964[f]	1967[d]	38	27	72	83
Brazil	Guanabara Demographic Pilot Survey, 1961	Jan. 1961	Dec. 1961	u	1964[d]	u	u	30	41
Republic of Korea	Korean Fertility Survey, 1968	Sept. 1968	Oct. 1968	Sept. 1969	Dec. 1970	12	11	26	27

Part B. World Fertility Surveys

Region, Country	Date Field Work Began (1)	Date Field Work Ended (2)	Date of First Country Report (3)	Elapsed Time in Months (1) to (3)	Elapsed Time in Months (2) to (3)
Africa					
Kenya	Aug. 1977	Apr. 1978	June 1980	34	26
Asia					
Bangladesh	Dec. 1975	Mar. 1976	Mar. 1979	40	36
Fiji	Feb. 1974	Apr. 1974	Dec. 1976	34	32
Indonesia	Mar. 1976	June 1976	Jan. 1979	28	25
Jordan	June 1976	Sept. 1976	Mar. 1980	45	42
Korea	Sept. 1974	Dec. 1974	Feb. 1978	41	38
Malaysia	Aug. 1974	Nov. 1974	May 1977	33	30
Nepal	Apr. 1976	June 1976	Oct. 1977	19	16
Pakistan	May 1975	Dec. 1975	Oct. 1976	17	10
Philippines	Feb. 1978	June 1978	Dec. 1979	22	18
Sri Lanka	Aug. 1975	Oct. 1975	June 1978	35	32
Thailand	Mar. 1975	Aug. 1975	Oct. 1977	31	26
Turkey	Sept. 1978	Nov. 1978	Aug. 1980	23	21

TABLE 4.12 (continued)

Region, Country	Date Field Work Began (1)	Date Field Work Ended (2)	Date of First Country Report (3)	Elapsed Time in Months	
				(1) to (3)	(2) to (3)
Latin America					
Colombia	May 1976	Aug. 1976	Apr. 1978	23	20
Costa Rica	July 1976	Nov. 1976	Oct. 1978	28	23
Dominican Republic	Apr. 1975	July 1975	Nov. 1976	20	17
Guyana	May 1975	Aug. 1975	Oct. 1979	53	50
Jamaica	Nov. 1975	Jan. 1976	Dec. 1979	50	47
Mexico	July 1976	Feb. 1977	Feb. 1979	31	24
Panama	Dec. 1975	Mar. 1976	Mar. 1978	27	24
Peru	July 1977	June 1978	May 1979	23	11

Note: u = unavailable

[a] Excluding field follow-up, if any.

[b] Providing estimates of vital events adjusted for omissions.

[c] Refers to the beginning of data collection in the Current Population Survey.

[d] Where the month of publication was unavailable, June was used for the calculations.

[e] Natality results published in August 1971 and mortality rates in October 1971. Mean (September) used for table.

[f] Draft reports submitted to the Government of India in April 1963 and February 1964. Mean (September) used for table.

Sources:
Part A: Marks et al. (1974:57-58).
Part B: Scott and Singh (1980).

Appendix A
Calculating Total Error in Fertility and Mortality Estimation

In much of this report the concept of total error is discussed in non-technical terms; to avoid the associated risks of oversimplification and lack of statistical rigor, this appendix provides a more precise discussion of the topic.

THE COMPONENTS OF MEAN SQUARE ERROR

Total error includes both sampling and non-sampling errors. The total error of estimate or the mean square error (MSE) can be considered as the sum of at least four error components:

a. Sampling variance is a measure of the variability of results from one sample to another sample from the same population. It arises because a sample rather than the whole population is covered. For a simple random sample, sampling variance decreases as the sample size increases. However, simple random sampling usually is not done; instead, clusters are utilized. In cluster sampling, the sampling variance decreases as the sample size increases for a given cluster size, while the variance usually increases as the cluster size increases for a fixed sample size. (The "cluster size" is the number of units in each cluster selected for the sample.) Sampling variance may also be reduced by stratification, as described in Chapter 4.

b. Simple response variance is defined as the variance of the observed values of independent measurements for an individual unit taken under the same conditions and averaged over the individual units (individual people, deaths, births, etc.).

More technically, it is $E(x_i - X_i)^2$, where E indicates the expected value over all possible responses for this unit and over all eligible units in the population, x_i is the observed value on a particular independent trial on unit i, and $X_i = E(x_i/i)$ is the conditional expected value for unit i over the trials, all under the survey conditions.

c. Correlated response variance is a measure of the variability due to intra-interviewer or intra-recorder correlation and biases that persist from unit to unit and trial to trial, that is, the tendency for an individual enumerator, interviewer, or registration official to make the same errors repeatedly or consistently in all assignments. Correlated response variance may also result from the same supervisor managing a group of interviewers or from the same editor or coder processing the results for a given individual who originally recorded the information. An example of the latter would be a coder who codes all of a particular interviewer's census forms and consistently codes that interviewer's badly written 7s as 4s. Correlated response variance increases with the average size of interviewer assignments but decreases as the number of interviewers in the survey increases.

Simple and special sample designs are required to estimate this component of error. Correlated response variance, like bias, exists in all three data collection methods: censuses, CR/VS systems, and surveys.

d. Biases refer to systematic errors that affect any data collection process taken under specified design conditions with the same constant error (Kish, 1965:509). Biases have many components and have many sources in the measurement process; they include both noncoverage and nonresponse. Examples include noncoverage or consistent underreporting of infant deaths or any other vital event, consistent underreporting or overreporting of age through the use of inaccurate event calendars, telescoping of events in time, and memory decay. Such biases may be inherent in the measurement process or they may be a result of training or supervision errors. Theoretically, in sample censuses and surveys, bias is not related to sample size nor to the number of interviewers nor to the size of their assignments, provided that the same quality of effort can be maintained. Bias can be estimated only by comparing sample or survey responses with other results presumed to be more accurate, such as records from other systems or results based on superior techniques.

For sample censuses and surveys the estimated variance will include the simple random-sample variance together with the simple response variance--as long as the latter is computed properly in accord with the selection design, which it often is not. In many area samples, the work of one or more interviewers is limited to a primary sampling unit, and to the extent that this is so, error from correlated response variance due to interviewers is included in the computed variances between those units. The net bias component is not included in the estimated variance, and hence when it is present the total error is underestimated. Biases are the most difficult components of error to detect or to estimate. The MSEs of large samples tend to be dominated by biases, because the sampling errors are small. However, for statistics based on subclasses and their comparison, sampling errors increase relative to constant biases, and in these cases sampling errors often predominate.

Several distinctions between biases and variable errors should be noted:

1. Biases can be best considered as average values determined by specified "essential conditions" of the data collection process--whether census, civil registration system, or survey. Their values remain largely unknown unless measured by some method external to the collection process or by internal inconsistencies. Such methods can be quality checks attached to the data collection process or comparisons with external sources. Variable errors, however, can be measured by using proper randomization designs that are internal to the data collection process, e.g., interviewers randomly allocated, coders randomly allocated, etc.
2. The total bias is the algebraic $\sum B(g)$ of components of bias, which are largely unknown and which may or may not tend to cancel each other.

The error terms and error formula are defined as follows:

B(g) = a bias component (where g refers to the same general survey conditions).
V(g) = a variable error.
m(g) = the number of units.

$\sum \frac{[V(g)]^2}{m(g)}$ = the sum of all variable error terms, representing diverse sources, expressed as a unit variable error divided by the number of units. This formula applies to cases in which the variable error terms are independent. If these terms are correlated there will also be covariance terms.

3. Hence, biases can be reduced only by improving the quality and accuracy of operations, by doing something better. Overall variable errors can be reduced and reliability increased by deciding to reduce some individual $[V(g)]^2$ or by increasing m(g). For example, in censuses where fertility or mortality data are collected or tabulated on a sample basis, more units might be included in the sample.

4. The effects of biases and of variable errors vary according to the type of statistics being generated. For example, systematic biases, which have large effects on overall means, can have negligible effects on comparisons of means and on regression statistics. Contrariwise, variable errors, which have negligible effects on the means of large samples, can have large effects on means of small subclasses, on comparisons between subclasses, and on regression statistics. Regression coefficients can be biased if there are variable errors in the independent variables.

MINIMIZING ERROR

All components contribute to the total error of results of any survey or sample census, and correlated response variance and bias can exist in censuses and CR/VS systems, too. Reducing any of the error components generally involves added costs. For surveys, different types and designs have certain advantages and disadvantages in the trade-offs of balancing costs against the total error of survey estimates. In all three basic data collection systems, simple or correlated response errors can be controlled or minimized by sound design of questionnaires and forms, good training and supervision of field staff, and the use of standardized approaches to respondents in the interview or reporting situation. Variable and constant biases can also be controlled to some extent in the same manner.

In surveys, the detection or elimination of some underreporting and some overreporting biases is theoretically possible by means of multi-round and dual-record systems or by analytical methods based on demographic models. The use of repeated measurement of a subsample of units and of interpenetrating subsamples in the design can supply estimates of all components of the mean square error other than bias (Cochran, 1977).

Resources for surveys and census samples could be allocated much more effectively if adequate data were available on the size of variance components and the costs of the actions required to reduce error by specified amounts. However, most surveys and sample censuses serve many purposes, collecting data on a wide variety of variables and subclasses, and optimization for all is not possible; multipurpose design is not yet far advanced. In practice, neither adequate cost data nor knowledge of the size of the variance components is available. Furthermore, designers of data collection systems almost always face restrictions over which they can exercise little if any control: the budget may be fixed but inadequate, the field organization may be permanent but staffed with minimally qualified personnel, the registration form may be essentially fixed, and so on. Hence, a "proximal," or conditionally optimum, approach is needed and applied in most situations. Nevertheless, it is important for the data collection designers to continually attempt to minimize total error, keeping balance in mind so that one does not pay to make trivial reductions in total error. One way of keeping total error in mind is to always evaluate design and management alternatives in relation to how they might influence the various components of the MSE.

Appendix B
Collecting Data on Recent and Cumulative Demographic Events

Due to the errors encountered in using simple retrospective questions to collect accurate data on vital rates, demographers have developed means of correcting or adjusting the data as well as indirect techniques for deriving estimates based on the data. Information on children ever born (CEB) by age of women in five-year age groups (or by five-year marriage-duration groups) permits recent fertility rates to be adjusted for reference-period errors. If data are also collected on the number of children born alive and now dead, indirect estimation procedures based on the proportion of children now dead by age of mother can produce estimates of childhood mortality. To accurately determine total CEB from census or survey data, it is usually recommended that at least the following three questions be asked of all women aged 15 and over:

(1) How many children born alive are now living in the household?
(2) How many children born alive are now living elsewhere?
(3) How many children born alive are now dead?
These questions are sometimes referred to as the summary Brass questions, after William Brass who pioneered their use (Brass, 1964).

It is also very desirable to ask each of these questions separately for male and for female children, resulting in six questions. If there are differences in reporting completeness between the two sexes, it is then possible to utilize sex ratios and male and female mortality levels in evaluating the data. The procedures for applying demographic techniques that use these cumulative data on children ever born and children surviving are described in Indirect Techniques for Demographic Estimation (Hill et al., 1981).

In measuring demographic phenomena through censuses and household surveys, attempts are frequently made also to count vital events occurring in the "recent" past by asking retrospective questions about the events of interest--say, birth, death, marriage, or migration. The reporting of such events can be improved by following a sample of households over time and using information about changes in household composition in addition to retrospective questions. Besides direct analysis of the information, whether collected retrospectively or over time, additional indirect techniques can be applied--for example, the Brass P/F method (Brass, 1975), which is based on the combination of data on cumulative fertility (or parity, P) with data on recent fertility (F).

Most of the following discussion focuses on the measurement of current fertility, but many of the errors that arise in measuring fertility are even more serious for other demographic variables. It is generally agreed, for example, that deaths are much more difficult to measure by direct census and survey approaches than are births.

There are several approaches to collecting data on current fertility retrospectively. Some of the questions most commonly asked are the following:

(a) Events in recent period(s) for each woman.
    (1) Births in the past calendar year (for example, January 1 to December 31, 1980).
    (2) Births in the past 12 or 24 months.
    (3) Births since some fixed "well-known" date or event in the recent past.
(b) Date of the most recent live birth to each woman.
    (1) Date obtained from a direct question asked only for the last live birth.
    (2) Date obtained from a complete fertility history, which would also yield data on cumulative fertility for each woman, as described above.

Asking for the date of the most recent birth requires an answer for every woman, and requires that attention be given to the last child. It forces a higher proportion of the women to give a positive response. This may yield more accurate reporting of events than asking for events in a specified period. In some cases, information on the two most recent live births is obtained.

The questions may be asked of either the woman herself or some other eligible (proxy) respondent. Male or female interviewers may put the questions to the respondent. Other persons may or may not be present at the interview. The woman of interest may or may not be married. She may be unavailable for interview because of migration or a temporary absence. Because live births are relatively rare events--in many LDCs, perhaps an average of one household in five will have had a birth in the past year--interviewers may become complacent and tend to substitute a single question for the entire household rather than asking about births for each woman. These factors and others all interact and may result in varying levels of interviewer and response errors.

Even if interviewers are well trained and consistently probe for additional information, respondents may have difficulty remembering and reporting correct dates for births and other events. This may occur because of poor memory or because respondents, in their eagerness to be helpful, report events that are outside the reference period--for example, they report births that occurred 15 months ago when asked a question on births during the past 12 months. Misdating of events is called "telescoping." Forward telescoping occurs if events that happened prior to the reference period are reported as having occurred during the period. Backward telescoping is the reverse: events that happened during the reference period are considered by the respondent to have preceded it.

Vallin (1975) estimated the extent of forward telescoping of deaths in a multi-round survey in Algeria through the use of overlapping survey reference periods and by comparing results with the incomplete civil registration data. Data from three survey rounds permitted the construction of three retrospective estimates of the crude death rate: 12.9, 16.3, and 18.0 per 1,000. Estimates for the prospective (follow-up) period were 15.4, 16.2, and 16.7 per 1,000. The first retrospective estimate was based on data from questions asked in the first round. By the third round, the retrospective questions were leading to the forward shifting of deaths into the observation period, compensating for omissions, among other things.

In a North Carolina study that tested the ability of interviewers to discover through interviews the existence of vital events known to have occurred, Horvitz (1966) reported 5 percent forward telescoping. Telescoping was higher among nonwhites than whites and higher for the questionnaire version that asked for events "since January 1" than for the version that asked for events "in the past 12 months."

The data from Colombia and Kenya shown in Table B.1 are based on field rechecks of unmatched survey events from experimental dual-record systems. The column labeled "temporal" under "out-of-scope events" indicates events that were telescoped into the reference period. It is not known the extent to which these events would have been balanced by events that may have been forgotten altogether or that were telescoped out of the reference period. Few data are available to determine the extent to which events are telescoped out of the reference period.

TABLE B-1 Number of Out-of-Scope Vital Events Reported in Experimental Dual-Record Systems, as Measured by Field Rechecks of Unmatched Survey Events

		Out-of-Scope Events				
			(Percent)			
	Total Number of Events Reported	Total Number	Total[a]	Geographic	Temporal	Conceptual
Colombia						
1972-1973						
Births						
Santander	1,552	107	7	4	1	1
Bolivar	1,024	117	11	6	4	1
Deaths						
Santander	294	16	5	2	1	2
Bolivar	174	17	10	3	2	4
Kenya						
First 6 Mos, 1972						
Births	971	167	17	12	4	1
Deaths	131	25	19	8	9	2

[a] Percentages do not add to the "total" in all cases because of rounding.

Sources: Colombia: Colombia (1976: Tables 12, 14, 16, 17, pp. 120, 121, 123).
Kenya: Abernathy and Booth (1977:31, 45).

The only way to throw more light on these problems is to arrange for multiple coverage of events, with overlapping reference periods that allow matching to be done as in the Algeria example noted above. Another example comes from Morocco. Using data from the three rounds of the 1961-63 multipurpose survey of Morocco, Sabagh and Scott (1967) estimated that for a single-round retrospective survey the gross error (overenumeration plus underenumeration) would have been 17 percent for births and 36 percent for deaths, while the net error would have been an overenumeration of 3 percent and 9 percent for births and deaths, respectively.

APPENDIX REFERENCES

Abernathy, J. R., and H. Booth (1977) Systems of Demographic Measurement: The Dual Record System, Retrospective Survey Subsystem. Scientific Report Series No. 29, International Program of Laboratories for Population Statistics. Chapel Hill, N.C.: University of North Carolina.

Brass, W. (1964) Uses of Census and Survey Data for the Estimation of Vital Rates. African Seminar on Vital Statistics. Addis Ababa; United Nations Economic Commission for Africa.

Brass, W. (1975) Methods for Estimating Fertility and Mortality from Limited and Defective Data. Chapel Hill, N.C.: Laboratories for Population Statistics, University of North Carolina.

Cochran, W. G. (1977) Sampling Techniques, 3rd ed. New York: John Wiley and Sons.

Colombia, Centro de Investigaciones en Methodos Estadisticos para Demografia (CIMED) (1976) Aspectos Methodologicos del Estudio CIMED - ERED, 1971-1974, (Vol. 1). Bogota, Colombia: Departamento Administrativo Nacional de Estadistica (DANE).

Hill, K., H. Zlotnik, and J. Trussell (1981) Indirect Techniques for Demographic Estimation. Committee on Population and Demography, Assembly of Behavioral and Social Sciences, National Research Council, National Academy of Sciences. (To be published as Manual X in the series of manuals on demographic analyses of the Population Division, United Nations.)

Horvitz, D. G. (1966) Problems in designing interview surveys to measure population growth. In Proceedings of the Social Statistics Section, pp. 245-249. Washington, D.C.: American Statistical Association.

Kish, L. (1965) Survey Sampling. New York: John Wiley and Sons.

Sabagh, G., and C. Scott (1967) A comparison of different survey techniques for obtaining vital data in a developing country. Demography 4(2):759-772.

Vallin, J. (1975) La mortalite en Algerie. Population 30(6):1023-1046.

Glossary

AGE HEAPING A tendency for enumerators or respondents to report certain ages instead of others; also called age preference or digit preference. Preference for ages ending in 0 or 5 is widespread.

AGE PATTERN OF FERTILITY The relative distribution of a set of age-specific fertility rates. It expresses the relative contribution of each age group to total fertility.

AGE RATIO The ratio of the population in a given age group to the average of the populations in the two neighboring age groups, times 100.

AGE-SPECIFIC FERTILITY RATE The number of births occurring during a specified period to women of a specified age or age group, divided by the number of person-years-lived during that period by women of that age or age group. When an age-specific fertility rate is calculated for a calendar year, the number of births to women of the specified age is usually divided by the midyear population of women of that age.

AGE-SPECIFIC MORTALITY RATE The number of deaths occurring during a specified period to persons (usually specified by sex) of a specified age or age group, divided by the number of person-years-lived during that period by the persons of that age or age group. When an age-specific mortality rate is calculated for a calendar year, the number of deaths to persons of the specified age is usually divided by the midyear population of persons of that age. Age-specific mortality rates are generally denoted by $_nM_x$, the annual death rate to persons aged x to x + n.

AGE STANDARDIZATION A procedure of adjustment of crude rates (birth, death, or other rates) designed to

reduce the effect of differences in age structure when comparing rates for different populations.

BIRTH HISTORY A report of the number and dates of all live births experienced by a particular woman; see also pregnancy history. The sex of each child, the survival of each child to the date of the interview, and, where pertinent, the date of death are also generally recorded.

BIRTH ORDER The ordinal number of a given live birth in relation to all previous live births of the same woman (e.g., 5 is the birth order of the fifth live birth occurring to the same woman).

BIRTH RATE See crude birth rate.

CHANDRASEKARAN-DEMING TECHNIQUE A procedure to estimate the coverage of two independent systems collecting information about demographic or other events, based on the assumption that the probability of an event being recorded by one system is the same whether or not the event is recorded by the other system. The events from both systems are matched to establish M, the number of events recorded by both systems; U_1, the number recorded only by system 1; and U_2, the number recorded only by system 2. The Chandrasekaran-Deming formula then estimates total events, N, as

$$\hat{N} = M + U_1 + U_2 + \frac{U_1 U_2}{M}.$$

CHILDBEARING AGES The span within which women are capable of bearing children, generally taken to be from age 15 to age 49 or, sometimes, to age 44.

CHILDREN EVER BORN(E) The number of children ever borne alive by a particular woman; synonymous with parity. In demographic usage, stillbirths are specifically excluded.

COHORT A group of individuals who experienced the same class of events in the same period. Thus an age cohort is a group of people born during a particular period, and a marriage cohort is a group of people who married during a particular period. The effects of a given set of mortality or fertility rates are often illustrated by applying them to hypothetical cohorts.

COHORT FERTILITY The fertility experienced over time by a group of women or men who form a birth or a marriage cohort. The analysis of cohort fertility is contrasted with that of period fertility.

CRUDE BIRTH RATE The number of births in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as births per 1,000 population. The crude birth rate for a single year is usually calculated as the number of births during the year divided by the midyear population.

CRUDE DEATH RATE The number of deaths in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as deaths per 1,000 population. The crude death rate for a single year is usually calculated as the number of deaths during the year divided by the midyear population.

CUMULATED FERTILITY An estimate of the average number of children ever borne by women of some age x, obtained by cumulating age-specific fertility rates up to age x; also often calculated for age groups.

DEATH RATE See crude death rate.

DE FACTO POPULATION A population enumerated on the basis of those present at a particular time, including temporary visitors and excluding residents temporarily absent. See de jure population.

DE JURE POPULATION A population enumerated on the basis of normal residence, excluding temporary visitors and including residents temporarily absent. See de facto population.

DIGITAL PREFERENCE See age heaping.

DUAL RECORD SYSTEM See Chandrasekaran-Deming Technique

EXPECTATION OF LIFE AT BIRTH The average number of years that a member of a cohort of births would be expected to live if the cohort were subject to the mortality conditions expressed by a particular set of age-specific mortality rates. Denoted by the symbol e(o) in life table notation.

FERTILITY HISTORY Either a birth history or a pregnancy history.

FORWARD SURVIVAL A procedure for estimating the age distribution at some later date by projecting forward an observed age distribution. The procedure uses survival ratios, often obtained from model life tables. The procedure is basically a form of population projection without the introduction of new entrants (births) to the population.

GENERAL FERTILITY RATE The ratio of the number of live births in a period to the number of person-years-lived by women of childbearing ages during the period. The

general fertility rate for a year is usually calculated as the number of births divided by the number of women of childbearing ages at midyear.

GROSS REPRODUCTION RATE The average number of female children a woman would have if she survived to the end of her childbearing years and if, throughout, she were subject to a given set of age-specific fertility rates and a given sex ratio at birth. This number provides a measure of replacement fertility in the absence of mortality.

GROWTH RATE The increase or decrease of a population in a period divided by the number of person-years-lived by the number of person-years-lived by the population during the same period. The increase in a population is the result of a surplus (or deficit) of births over deaths and a surplus (or deficit) of immigrants over emigrants. (The annual increase is often expressed as a fraction of the total population at the beginning of the year, but this convention has the inconvenient characteristic of not being readily defined for a five-year interval and of being unequal to the difference between the birth rate and the death rate even in the absence of migration.) See also rate of natural increase.

INFANT MORTALITY RATE The number of deaths of children under 1 year of age occurring in the same year; also used in a more rigorous sense to mean the number of deaths that would occur under 1 year of age in a life table with a radix of 1,000, in which sense it is denoted by the symbol $_1q_0$.

LIFE TABLE A listing of the number of survivors at different ages (up to the highest age attained) in a hypothetical cohort subject from birth to a particular set of age-specific mortality rates. The rates are usually those observed in a given population during a particular period of time. The survivors of the radix to age x are generally denoted by l(x). The tabulations commonly accompanying a life table include other features of the cohort's experience: its expectation of life at each age x, denoted by e(x); the probability of surviving from each age x to age x + n, denoted by $_nq_x$; the person-years-lived by the hypothetical cohort as it ages from age x to age x + n, denoted by $_nL_x$ (also equivalent to the population aged x, x + n in a stationary population experiencing a number of births each year equal to the radix of the life table); and the person-years-lived

by the hypothetical cohort from age x onward, denoted by T(x).

LOGIT The logit of a proportion p is $1/2 \ln[p/(1 - p)]$. As a linearizing transformation, the logit has been proposed as the basis of a model life table system in which the logit of a probability of dying by age x ($_xq_0$) is related linearly to the logit of a standard probability of dying by age x ($_xq_0^s$) so that

$$\text{logit } ({}_xq_0) = \alpha + \beta \, [\text{logit } ({}_xq_0^s)],$$

where α is a measure of mortality level relative to the standard and β is a parameter that alters the shape of the standard mortality function.

MARITAL FERTILITY Any measure of fertility in which the births (in the numerator) are births to married women and in which the number of person-years-lived (in the denominator) also pertains to married women. In some instances, the designation "married" includes persons in consensual unions.

MEDIAN The value associated with the central member of a set that is ordered by size or some other characteristic expressed in numbers.

MEAN AGE OF CHILDBEARING The average age at which a mortality-free cohort of women bear their children according to a set of age-specific fertility rates.

MEAN AGE OF CHILDBEARING IN THE POPULATION The average age of the mothers of the children born in a population during a year. This measure incorporates the effects of both mortality and the age distribution.

MIGRATION RATE Number of migrants during a specified period divided by the person-years-lived of the population exposed to migration. Also see population change due to migration.

MODEL LIFE TABLE An expression of typical mortality experience derived from a group of observed life tables.

MOVING AVERAGES The successive averaging of two or more adjacent values of a series in order to remove sharp fluctuations.

MYERS INDEX An index of digit preference that essentially sums in turn the population ending in each digit over some age range, often 10-89, expressing the total as a percentage of the total population, and which avoids the bias introduced by the fact that the population is not evenly distributed among all ages by repeating the calculations 10 times, once for each

starting digit, and averaging the results. The difference between the average percentage for each digit and the expected value of 10 percent provides a measure of the preference for or avoidance of the digit over the age range considered.

NATURAL FERTILITY The age pattern of marital fertility observed in non-contraceptive populations where reproductive behavior is not affected by the number of children already born.

NET MIGRATION The difference between gross immigration and gross emigration.

NET REPRODUCTION RATE The average number of female children born per woman in a cohort subject to a given set of age-specific fertility rates, a given set of age-specific mortality rates, and a given sex ratio at birth. This rate measures replacement fertility under given conditions of fertility and mortality: it is the ratio of daughters to mothers assuming continuation of the specified conditions of fertility and mortality.

OWN-CHILDREN METHOD A refinement of the reverse-survival procedure for fertility estimation, whereby estimates of age-specific fertility rates for the recent past are obtained by relating mothers to their own children, using information on relationship and other characteristics available from a census or survey.

PARITY See children ever born.

PARTIAL BIRTH RATE The proportion of the population that enters (that is, is "born" into) a given age category in a year. The age categories used are normally open-ended, thus the partial birth rate x+ designates the proportion of the population becoming x years and older.

PARTIAL DEATH RATE The proportion of the population that leaves (that is, "dies" out of) a given age category in a year. See partial birth rate.

PERIOD FERTILITY The fertility experienced during a particular period of time by women from all relevant birth or marriage cohorts; see also cohort fertility.

P/F RATIO METHOD A consistency check for survey information on fertility. Information on recent fertility is cumulated to obtain measures that are equivalent to average parities. Lifetime fertility in the form of reported average parities by age group (P) can then be compared for consistency with the parity-equivalents (F) by calculating the ratio P/F for successive age groups. If certain assumptions

about error patterns are met, an improved estimate of fertility can sometimes be obtained by correcting the age pattern of current fertility to agree with the level of lifetime fertility reported by younger women.

POPULATION CHANGE DUE TO MIGRATION The sum of in-migrants minus out-migrants during a specified period of time. The change may also be expressed as a rate by dividing the change by person-years-lived in the population during the same period.

PREGNANCY HISTORY A report of the number and the dates of occurrence of all the pregnancies experienced by a particular woman. The outcome of the pregnancy--live birth, stillbirth, fetal death--is also recorded.

RADIX The hypothetical birth cohort of a life table. Common values are 1, 1,000, and 100,000.

RATE OF NATURAL INCREASE The difference between the births and deaths occurring during a given period divided by the number of person-years-lived by the population during the same period. This rate, which specifically excludes changes resulting from migration, is the difference between the crude birth rate and the crude death rate.

RETROSPECTIVE SURVEY A survey that obtains information about demographic events that occurred in a given past period, generally terminating at the time of the survey.

REVERSE PROJECTION See reverse survival.

REVERSE SURVIVAL A technique to estimate an earlier population from an observed population, allowing for those members of the population who would have died according to observed or assumed mortality conditions. It is used as a method of estimating fertility by calculating from the observed number of survivors of a given age x the expected number of births that occurred x years earlier. (In situations for which both fertility and mortality are known or can be reliably estimated, reverse survival can be used to estimate migration.)

ROBUSTNESS A characteristic of estimates that are not greatly affected by deviations from the assumptions on which the estimation procedure is based.

SEX RATIO AT BIRTH The number of male births for each female birth, or male births per 100 female births.

SINGULATE MEAN AGE AT MARRIAGE (SMAM) A measure of the mean age at first marriage, derived from a set of proportions of people single at different ages or in

different age groups, usually calculated separately for males and females.

STABLE POPULATION A population exposed for a long time to constant fertility and mortality rates, and closed to migration, establishes a fixed age distribution and constant growth rate characteristic of the vital rates. Such a population, with a constant age structure and constant rate of growth, is called a stable population.

STATIONARY POPULATION A stable population that has a zero growth rate, with constant numbers of births and deaths per year. Its age structure is determined by the mortality rates and is equivalent to the person-years-lived ($_nL_x$) column of a conventional life table.

SURVIVAL RATIO The probability of surviving between one age and another; often computed for age groups, in which case the ratios correspond to those of the person-years-lived function, $_nL_x$, of a life table. Also called survivorship probabilities.

SURVIVORSHIP PROBABILITIES See survival ratio.

SYNTHETIC PARITY The average parity calculated for a hypothetical cohort exposed indefinitely to a set of period age-specific fertility rates.

TOTAL FERTILITY RATE (TFR) The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given set of age-specific fertility rates; also referred to as total fertility. It is frequently used to compute the consequence of childbearing at the rates currently observed.

UNITED NATIONS AGE-SEX ACCURACY INDEX An index of age reporting accuracy that is based on deviations from the expected regularity of population size and sex ratio, age group by age group. The index is calculated as the sum of (1) the mean absolute deviation from 100 of the age ratios for males, (2) the mean absolute deviation from 100 of the age ratios for females, and (3) three times the mean of the absolute difference in reported sex ratios from one age group to the next. The United Nations defines age-sex data as "accurate," "inaccurate," or "highly inaccurate" depending on whether the index is less than 20, 20 to 40, or greater than 40.

WHIPPLE'S INDEX A measure of the quality of age reporting based on the extent of preference for a particular target digit or digits. The index

essentially compares the reported population at ages ending in the target digit or digits with the population expected on the assumption that population is a linear function of age. For a particular age range, often 23 to 62, the population with ages ending in the target digits is divided by one-tenth of the total population, the result then being multiplied by 100 and divided by the number of different target digits. A value of 100 indicates no preference for those digits, whereas values over 100 indicate positive preference for them.

R6000-5.7

COMMITTEE ON
POPULATION AND DEMOGRAPHY

Report No. 8

Trends in Fertility and Mortality in Turkey, 1935-1975

Frederic C. Shorter
Miroslav Macura

Panel on Turkey
Committee on Population and Demography
Assembly of Behavioral and Social Sciences
National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1982

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

Library of Congress Catalog Card Number 81-86661
International Standard Book Number 0-309-03239-3

Available from:

NATIONAL ACADEMY PRESS
2101 Constitution Ave., N.W.
Washington, D.C. 20418

Printed in the United States of America

PANEL ON TURKEY

NUSRET H. FIŞEK, Institute of Community Medicine,
Hacettepe University, Ankara, Turkey
SEVİNÇ KAVADARLI, Institute of Population Studies,
Hacettepe University, Ankara, Turkey
MIROSLAV MACURA, Economic Institute, Belgrade, Yugoslavia
FERHUNDE ÖZBAY, Research Institute of Social Sciences,
Ankara Academy of Economics and Commerce, Ankara,
Turkey
FREDERIC C. SHORTER. The Population Council, Cairo, Egypt
SAMİRA YENER, State Planning Organization, Ankara, Turkey

ROBERT J. LAPHAM, *Study Director*

COMMITTEE ON POPULATION AND DEMOGRAPHY

ANSLEY J. COALE (*Chair*), Office of Population Research, Princeton University
WILLIAM BRASS, Centre for Population Studies, London School of Hygiene and Tropical Medicine
LEE-JAY CHO, East-West Population Institute, East-West Center, Honolulu
RONALD FREEDMAN, Population Studies Center, University of Michigan
NATHAN KEYFITZ, Department of Sociology, Harvard University
LESLIE KISH, Institute for Social Research, University of Michigan
W. PARKER MAULDIN, Population Division, The Rockefeller Foundation, New York
JANE MENKEN, Office of Population Research, Princeton University
SAMUEL PRESTON, Population Studies Center, University of Pennsylvania
WILLIAM SELTZER, Statistical Office, United Nations
CONRAD TAEUBER, Kennedy Institute, Center for Population Research, Georgetown University
ETIENNE VAN DE WALLE, Population Studies Center, University of Pennsylvania

ROBERT J. LAPHAM, *Study Director*

NOTE: Members of the Committee and its panels and working groups participated in this project in their individual capacities; the listing of their organizational affiliation is for identification purposes only, and the views and designations used in this report are not necessarily those of the organizations mentioned.

Contents

LIST OF TABLES vii

LIST OF FIGURES ix

PREFACE xi

SUMMARY 1

Fertility, 2
Mortality, 6
Population Growth, 8

1 INTRODUCTION 12

Background, 12
Data Sources, 13

2 FERTILITY 20

National Crude Birth Rates, 1935-75, 20
National Total Fertility Rates, 1935-75, 29
National Trends in Marital Fertility, 1935-75, 36
Fertility by Divisions of the Population, 1945-68, 42

3 MORTALITY 56

National Infant and Early Childhood Mortality, 1945-75, 56

Infant and Early Childhood Mortality by Divisions, 1945-67, 68
National Mortality Above Age 5, 1935-75, 81
National General Mortality, 1935-75, 91

4 NATIONAL POPULATION GROWTH, 1935-75 96

Components of Population Increase, 96
Sum of Components, 99

APPENDIXES 101

A Estimation of Fertility by Multiple Reverse Projection, 101

B Estimation of Trends in Infant and Early Childhood Mortality from Birth-Survival Histories, 111

C Adjustment of the National Censuses for Age Misreporting, 117

D International Migration, 124

E Population of Six Divisions by Age and Sex, 1945-70, 129

GLOSSARY 137

REFERENCES 147

List of Tables

1 Population of Turkey by Age and Sex as Reported in the Censuses, 1935 to 1975 14
2 National Crude Birth Rates, 1935-75, Estimated by Multiple Reverse Projection 24
3 Summary of National Crude Birth Rate Estimates, 1935-75 28
4 Percentage National Diistribution by Age of Marital Fertility, 1963-73, Compared with a Schedule of Natural Fertility 30
5 National Proportions of Females Married by Age, from 1935-75 Censuses 31
6 National Proportions of Married Women Currently Using Some Method of Contraception by Age Group, Derived from National Sample Surveys in 1963, 1968, and 1973 33
7 National Fertility Indexes, 1935-75 37
8 National Number of Women Ever Married, per 1,000 Women by Cohorts, and Mean Age of First Marriage (SMAM), 1930-35 to 1970-75 39
9 Population Size and Growth by Six Divisions, 1945-70 44
10 Estimation of Crude Birth Rate for Istanbul and Izmir, 1945-68 46
11 Estimated Crude Birth Rates by Six Divisions, 1945-68 46
12 Proportions Married Females by Divisions of the Population, 1945-68 and Standard Marital Fertility Schedule 48
13 Fertility and Marriage Indexes by Divisions, 1945-68 51
14 Components of Urban Population Growth, 1945-70 52
15 Births by Education of Mother, Standardized by Duration of Marriage, from the 1968 Hacettepe Survey 54
16 National Life Table, Based on One Year of Data Centered on February 1967 60
17 Age Patterns of Early Childhood Mortality in

Turkish Life Tables and in the "East" and "West" Families of Model Life Tables 63
18 National Infant Mortality Rate, 1945-70 64
19 Estimates of the National Infant Mortality Rate Based on Reports of Mothers at Different Ages, Four Sources 65
20 Estimates of Infant Mortality by Divisions, 1945-70 69
21 Infant Mortality Rates by Divisions from Birth-Survival Histories (BSH) Compared with Brass-Trussell Estimates from Various Sources, 1960, 1963, 1967 70
22 Adjustment of Urban Infant Mortality Rate for Transfer of Rural Communities to Urban Sector, 1945 78
23 Urban Infant Mortality Rates Adjusted for Reporting Error Due to Migration of Mothers and Transfers of Communities from Rural to Urban, 1945-67 79
24 Infant Mortality and Fertility Indexes by Province, Circa 1967 and 1960 84
25 Estimates of Mortality Above Age 5 by Forward Projection, 1935-75 89
26 Sex Differentials in Infant and Early Childhood Mortality Compared with Differential Predicted by the "East" Models 92
27 Expectation of Life at Birth, 1945-75 93
28 National Mortality Assumptions of the Multiple Reverse Projections, 1935-75 95
29 Rates of Population Change and Two Alternative Estimates of the Death Rate, 1935-75 97
A-1 Sample Reverse Projection from 1975 108
C-1 Proportions of "True" Population of Females in 1955 Transferred Upward or Downward from Five-Year Age Groups by Misreporting 118
C-2 Comparison of Demeny-Shorter (D-S) and P. Das Gupta (PDG) "Corrections" of Age Distributions for Misstatement of Age, Females, 1955 and 1960 119
C-3 Population by Age and Sex, Corrected for Age Misreporting, 1935-75 122
D-1 Demographic Effect of International Migration on National Population Size, 1935-75 126
D-2 Average Yearly International Migration for Intercensal Periods, 1935-75 127
D-3 Distribution of Net International Migration by Age, for Each Sex, 1960-75 128
E-1 Population of Six Divisions by Age and Sex as Reported in the Censuses, 1945-70 130

List of Figures

1 National Fertility Indexes, 1935-75 3
2 Crude Birth Rate, Total Fertility Rate, and Births by Rural-Urban Areas, 1945-68 5
3 Mortality Measures for Both Sexes Combined, 1935-75 7
4 Infant Mortality Rates by Rural-Urban Areas, 1945-67 9
5 Overall Rate and Components of National Population Increase, 1935-75 10
6 Estimates of Crude Birth Rate Based on Reported Age Distribution from One Census at End of Five-Year Period and Estimates Based on Distribution from all Available Censuses, 1935-75 25
7 Distribution by Age of Marital Fertility Under Natural and Controlled Conditions, Early 1960s and 1973 32
8 Estimates of Total Fertility Rate, 1935-75 34
9 National Mean Age of First Marriage for Cohorts and Current Index of Proportion Married (C_m), 1935-75 41
10 Urban-Rural and Regional Divisions of Turkey 43
11 Distribution of Marital Fertility by Age, from 1963 National Population Survey 49
12 Fertility Measures and Marriage Indexes, 1935-75 50
13 Total Fertility Rates by Province, 1960 53
14 Survivors from a Cohort of 100,000 Female Births (ℓ_x). Four Regional Models with same Values for ℓ_1 for Demographic Survey Estimates, 1966-67 62
15 Early Childhood Mortality Expressed in Terms of Infant Mortality Rate, 1945-75 66

16 Comparison of Infant Mortality Estimates from Birth-Survival Histories with Independent Brass-Trussell Estimates by Rural-Urban Divisions 71
17 Comparison of Infant Mortality Estimates from Birth-Survival Histories with Independent Brass-Trussell Estimates by Regions within Rural and Urban Divisions 72
18 Infant Mortality Rates by Divisions, 1945-67 80
19 Infant Mortality Rates by Provinces, 1967 82
20 Comparison of Mortality Above Age 5 in Turkish Life Tables with Four Families of Model Life Tables 87
21 Estimates of Mortality Above Age 5 by Forward Projection, 1935-75 90
22 Changes in the Deviant Child-Adult Pattern of Turkish Mortality, 1945-75 94
23 Alternative Estimates of the Crude Death Rate, 1935-75 98

A-1 Comparison of Estimates of CBR from Censuses Spaced Five and Ten Years Apart 110
C-1 Age Errors by Sex: Difference Between Enumerated and Corrected Population by Five-Year Age Groups 120
C-2 Population by Age and Sex Corrected for Age Misreporting, 1935 and 1975 121

Preface

The Committee on Population and Demography was established in April 1977 by the National Research Council in response to a request by the Agency for International Development (AID) of the U.S. Department of State. It was widely felt by those concerned that the time was ripe for a detailed review of levels and trends of fertility and mortality in the developing world. Although most people in the demographic community agree that mortality has declined in almost all developing countries during the last 30 years, there is uncertainty about more recent changes in mortality in some countries, about current levels of fertility, and about the existence and extent of recent changes in fertility.

In 1963, a Panel on Population Problems of the Committee on Science and Public Policy of the National Academy of Sciences published a report entitled The Growth of World Population. The appointment of that panel and the publication of its report were expressions of the concern then felt by scientists, as well as by other informed persons in many countries, about the implications of population trends. At that time, the most consequential trend was the pronounced and long-continued acceleration in the rate of increase of the population of the world, and especially of the population of the poorer countries. It was estimated in 1963 that the annual rate of increase of the global population had reached 2 percent, a rate that, if continued, would cause the total to double every 35 years. The disproportionate contribution of low-income areas to that acceleration was caused by rapid declines in mortality combined with high fertility that remained almost unchanged: the birth rate was nearly fixed or declined more modestly than the death rate.

Since the earlier report, however, the peak rate of growth in the world's population has apparently been passed. A dramatic decline in the birth rate in almost all the more developed countries has lowered their aggregate annual rate of increase to well below 1 percent, and the peak rate of increase has also apparently been passed in the less-developed parts of the world as a whole. A sharp decline in fertility in many low-income areas has more than offset the generally continued reduction in the death rate, although the rate of population increase remains high in almost all less-developed countries.

The causes of the reductions in fertility--whether they are the effect primarily of such general changes as lowered infant mortality, increasing education, urban rather than rural residence, and improving status of women or of such particular changes as spreading knowledge of and access to efficient methods of contraception or abortion--are strongly debated. There are also divergent views of the appropriate national and international policies on population in the face of these changing trends. The differences in opinion extend to different beliefs and assertions about what the population trends really are in many of the less-developed countries. Because births and deaths are recorded very incompletely in much of Africa, Asia, and Latin America, levels and trends of fertility and mortality must be estimated, and disagreement has arisen in some instances about the most reliable estimates of those levels and trends.

It was to examine these questions that the Committee on Population and Demography was established within the Assembly of Behavioral and Social Sciences of the National Research Council. It was funded initially for a period of three years by AID under Contract No. AID/pha-C-1161. The Committee has undertaken three major tasks:

1. To evaluate available evidence and prepare estimates of levels and trends of fertility and mortality in selected developing nations;
2. To improve the technologies for estimating fertility and mortality when only incomplete or inadequate data exist (including techniques of data collection);
3. To evaluate the factors determining the changes in birth rates in less-developed nations.

Given the magnitude of these tasks, the Committee decided to concentrate its initial efforts on the first two tasks; it initiated work on the third task in 1979.

The Committee approaches the first task through careful assessment, by internal and external comparison, and through analysis, by application of the most reliable methods known, of all the data sources available. Each of the country studies therefore consists of the application of a range of methods to a number of data sets. Best estimates of levels and recent trends are then developed on the grounds of their consistency and plausibility and the robustness of the individual methods from which they were derived.

The Committee's second task, refinement of methodology, is seen as a by-product of achieving the first. The application of particular methods to many different data sets from different countries and referring to different time periods will inevitably provide valuable information about the practical functioning of the methods themselves. Particular data sets might also require the development of new methodology or the refinement of existing techniques.

The Committee set three criteria for identifying countries to study in detail: that the country have a population large enough to be important in a world view; that there be some uncertainty about levels and recent trends of fertility or mortality; and that sufficient demographic data be available to warrant a detailed study. After a country has been selected for detailed study, the usual procedure is to set up a panel or working group of experts, both nationals of the country and others knowledgeable about the demography and demographic statistics of the country. The role of these panels and working groups, which generally include at least one Committee member, is to carry out the comparisons and analyses required. A small staff assists the Committee, panels, and working groups in their work.

As of late 1981, 168 population specialists, including 94 from developing countries, have been involved in the work of the Committee as members of panels or working groups. The Committee, the Assembly, and the National Research Council are grateful for the unpaid time and effort these experts have been willing to give.

Each country being studied has a different mix of data sources and different problems with data errors. Therefore, there is no standard pattern for all the reports. However, each report includes a summary of the main findings regarding estimates of fertility and mortality, a description of the data sources available, and a presentation of the analyses that were carried out, classified by type of data analyzed; detailed methodological descriptions are included where necessary in appendixes.

In some of the reports the estimates of fertility and mortality are presented as ranges. The use of a range is deliberate. It indicates that the panel and the Committee are confident that the range includes the true value, but have concluded that the evidence does not warrant selecting a single figure as best. The range conveys an important aspect (uncertainty) of the estimation. Ideally, in constructing an average for several populations in each of which estimation is presented as a range, an aggregate range would be calculated (as the population-weighted average of the constituents). The user who selects a single figure from the middle of the range does so at the risk of misleading simplification.

This report is number 8 in a series produced by the Committee. The report analyzes available data and provides estimates of the levels and recent trends of fertility and mortality in Turkey. It has been prepared by Frederic C. Shorter and Miroslav Macura with advice, consultation, and technical review provided by the other members of the Panel.

The Panel on Turkey was formed in 1978, with assistance from the Institute of Population Studies and the Institute of Community Medicine at Hacettepe University in Ankara, Turkey. The Institute of Population Studies arranged meeting space and provided other assistance to the Panel during the two Panel meetings held in 1978 and in 1980. Appreciation is extended to both Institutes and especially to Mithat Corun, director of the Institute of Population Studies at that time.

The Panel has functioned primarily in the planning and development of the project and in providing technical advice and critical review of the report. Review of draft tabulations and of the draft manuscript was carried out periodically between 1978 and 1980, both during and between Panel meetings. The Panel reviewed and approved the final manuscript.

The Turkey report is somewhat more detailed than other reports of the Committee because the Panel felt that a more detailed exposition would be useful for demographers and other persons concerned about population measurement in Turkey.

Special thanks and appreciation are due to Nusret H. Fişek, professor of community medicine and director of the Institute of Community Medicine, Hacettepe University. Dr. Fişek has been associated with population research and service delivery programs in Turkey for two decades, and he has provided an extensive background and insightful knowledge of population data and population phenomena in Turkey. Dr. Fişek was the first director of the Institute of Population Studies, a post he held for five years. In 1967 he organized the still-functioning Etimesgut Rural Health District, where integrated health services, including family planning, are provided to 80,000 people. The area is also used for epidemiologic, demographic, and health services research. Dr. Fişek was also instrumental in the establishment by the Institute of Community Medicine in 1975 of a field training and research program in the Cubuk Rural Health District (population 55,000). The Institute of Community Medicine is a collaborating center of the World Health Organization (WHO) in research and training on service delivery in the field of human reproduction.

This report takes into account and extends much prior analysis of population statistics for Turkey by the present authors and by other scholars whose work is referenced throughout this report. Most of this work has been done under the auspices of the Institute of Population Studies, the State Institute of Statistics, and the State Planning Organization of Turkey. Appreciation is expressed to the Institute of Population Studies for providing pregnancy history tabulations from the 1968 and 1973 fertility surveys.

The assistance of several individuals is acknowledged with warm thanks. Mahir Ulusoy and Osman Saracbasi of Hacettepe University produced the 1968 and 1973 pregnancy history tabulations. Robert Sendek of the Center for Policy Studies, Population Council, made useful tabulations from the 1963 Survey. Kadir Sumbuloglu, associate professor of biostatistics, Institute of Community Medicine, Hacettepe University, analyzed Turkey death registration data from province and district centers. Denise Batani, a graduate student in the Department of Statistics, University of Cairo, assisted with computations.

The Committee extends its sincere thanks for this study to all members of the Panel on Turkey, who managed amid busy schedules to assist with this project. Thanks are also extended to the staff of the Committee for their

support, assistance, and advice. Katherine Miller edited the report and provided many ideas and suggestions for clarity and presentation. Eugenia Grohman, associate director for reports of the Assembly of Behavioral and Social Sciences, provided technical advice, and Elaine McGarraugh, editorial assistant, coordinated its production with the National Academy Press. Special thanks are due to Brenda Buchbinder, administrative assistant, for assisting with travel arrangements and other administrative tasks, and to Solveig Padilla, Benita Anderson, and Isis Bassili for typing the text and many tables. Carol Bradford Ward helped organize and proofread the tabulations and figures.

The Committee is also grateful to the individuals who have assisted in the review of early drafts of this report and to the members of the Assembly of Behavioral and Social Sciences and outside reviewers who reviewed the final draft. Their comments and suggestions have been most useful.

The Committee extends sincere appreciation to all of the individuals and institutions for their time and for the materials they provided for the preparation of this report.

ANSLEY J. COALE, *Chair*
Committee on Population and Demography

Summary

The data for this evaluation of fertility and mortality trends in Turkey cover a period of 40 years, from 1935 to 1975. The information is strongest and most detailed between 1945 and 1970, which includes the period when fertility commenced a sustained decline. This assessment examines both national trends and trends among divisions of the country. Since redistribution of the population by urbanization has been a major factor in the demography of the country, some information on these trends is also presented.

The Turkish transition from high birth and death rates was well advanced by the mid-1970s, but it was still far from reaching the low levels of European countries. During 1970-75, the most recent period for which reliable measures are available, the expectation of life at birth averaged 59 years, the infant mortality rate was approximately 126 deaths per thousand births, the crude birth rate was 34.9 per thousand population, and the total fertility rate was 5.05 children per woman.

After the work on the present report was completed, preliminary results of a national fertility survey conducted in 1978 became available. While these data may be subject to certain types of error, which would require adjustment when full details become available, they indicate a total fertility rate of 4.3 children per woman in 1977-78. An extrapolation of the accelerating downward trend from five years earlier yields a total fertility rate of 4.5 at the same date.

This summary presents an overview of the findings of the report, but reference must be made to the body of the report to obtain a more complete picture, including evaluation of the quality of estimates.

FERTILITY

The national fertility trend is measured by three major indexes: an index of fertility within marriage, the total fertility rate, and the crude birth rate. These three fertility indexes are related to each other through two intermediate indexes: an index of the proportions of women in the married state, and an index of age and sex structure for the population (see Figure 1).

Fertility within marriage is measured by the sum of age-specific marital fertility rates over the reproductive ages of women. The sum, which is denoted total marital fertility, began declining from a high plateau during the late 1940s or early 1950s, the exact year being impossible to specify with available data. The development of fertility control in some social groups within marriage probably predated the national decline of fertility because there were pre-existing differentials affecting at least small urbanized sections of the population. The sustained decline of marital fertility is accompanied by changes in the age pattern of marital fertility rates that clearly indicate increases in voluntary limitation of births. Indirect confirmation of the rise in birth planning is provided by data on contraceptive use by the married population over a limited segment of the trend period, from 1963 to 1973.

The total fertility rate, which measures the number of children women have on average given current age-specific rates, began its descent somewhat later than the decline of fertility within marriage. The reason for this delay was an increase in proportions of women exposed to childbearing up to the mid- or late 1950s. The marriage index, C_m, shows the proportions of women in a married state during the ages of potential childbearing increased. The upward trend in exposure was due to a downward trend in the age of marriage and to reductions in widowhood, the latter a consequence mainly of rising life expectancy for husbands. Only since the mid-1950s has the average age of first marriage for women begun to rise.

The overall decline of the total fertility rate is from a pre-decline level of 6.85 children to 5.05 children during 1970-75, amounting to 26 percent. Preliminary estimates from the 1978 national survey indicate that the decline is 37 percent when extended to a period of about 25 years. The rate of decline has been accelerating.

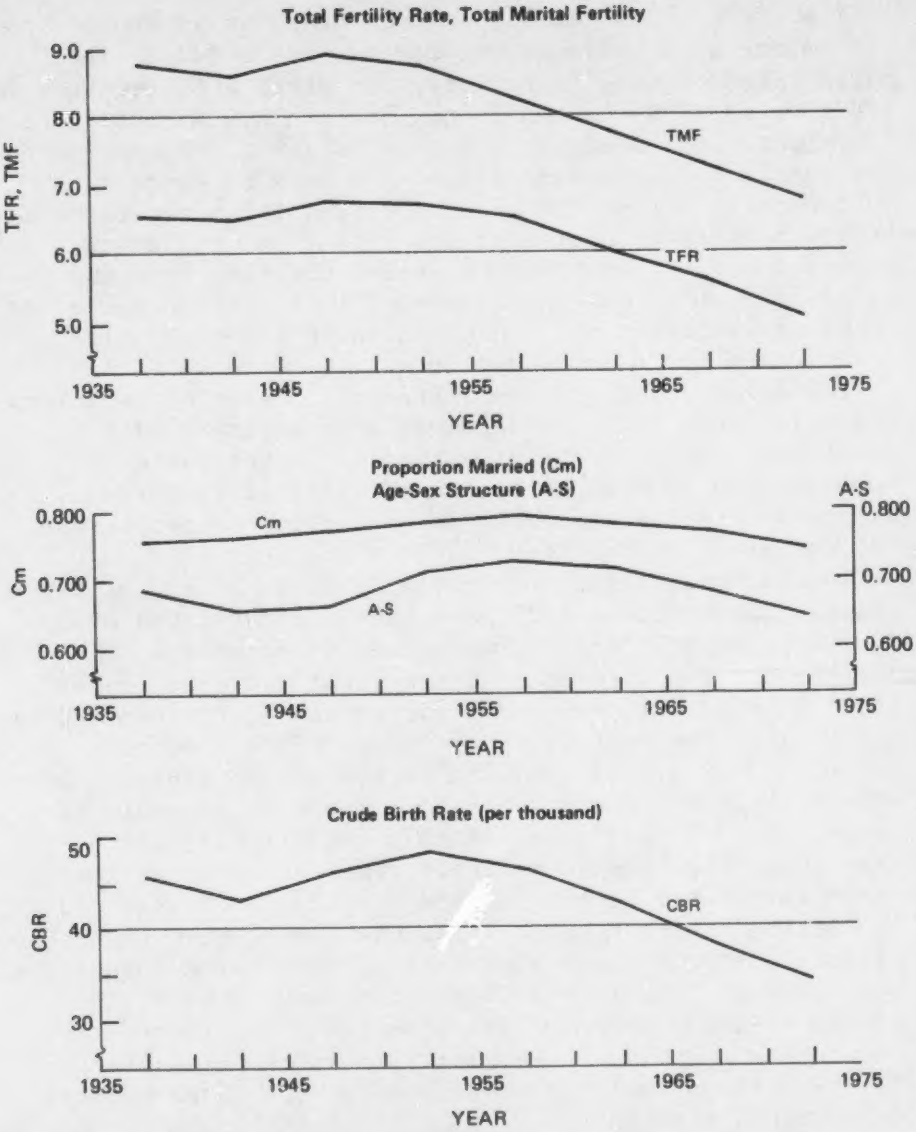


FIGURE 1 National Fertility Indexes, 1935-75: Turkey

The decline of total fertility up to 1970-75 can be factored into two elements: the decline of fertility within marriage and the reduction of marriage proportions. Eighty-one percent of the decline is due to reductions in marital fertility. Only 19 percent is due to marriage factors, specifically a rise in age of marriage, which came late, and some offsets due to declining widowhood.

The crude birth rate, which measures the growth of the population as a whole due to births, responded to the basic trend of total fertility, but it is affected in addition by slow changes in the age and sex structure of the population, denoted by A-S in Figure 1. Vacancies in the female age structure around the ages of highest childbearing during the late 1930s and 1940s are traceable to low numbers of births or low infant and childhood survival or some combination around the time that the Turkish Republic was established (1923). These vacancies meant fewer births and a depression in the crude birth rate during the period from roughly 1935 to 1950.

The exact trends of the different indexes of fertility prior to about 1950 are impossible to estimate with precision, due to certain weaknesses in the basic data. However, the general existence of a fertility plateau, with moderate fluctuations due to various causes before the decline, is confirmed.

The national trends of fertility from the end of the plateau period up to 1970 have been disaggregated by dividing the population into either three or six divisions. The three-part urban-rural division places the cities of Istanbul and Izmir at the most urban end of the scale. The rest of urban Turkey forms a second division. Ankara is included in the second division even though it is intermediate in size between Istanbul and Izmir. During the period of this study Ankara was a less urbanized city, demographically speaking, because its birth rates were higher and the proportion of the population having rural origins was higher than in Istanbul-Izmir. Rural communities, those with population less than 10,000, form a third division. Some of the analysis uses a six-part division involving three geographic regions of the rural and urban categories. Figure 2 shows fertility measures for the three major rural-urban divisions.

Based on the three-part urban-rural division, fertility in the mid-1940s was more than twice as high in rural Turkey as compared with Istanbul-Izmir, with the fertility of the "other urban" population intermediate between the two. Istanbul-Izmir was close to a replacement level of fertility in the late 1940s. Differentials of this type, which very likely had existed for some time, have narrowed somewhat since then. Rural fertility declined from the very beginning and there was a slight elevation of urban fertility, which then leveled off. However, the differential was still large in 1968, with

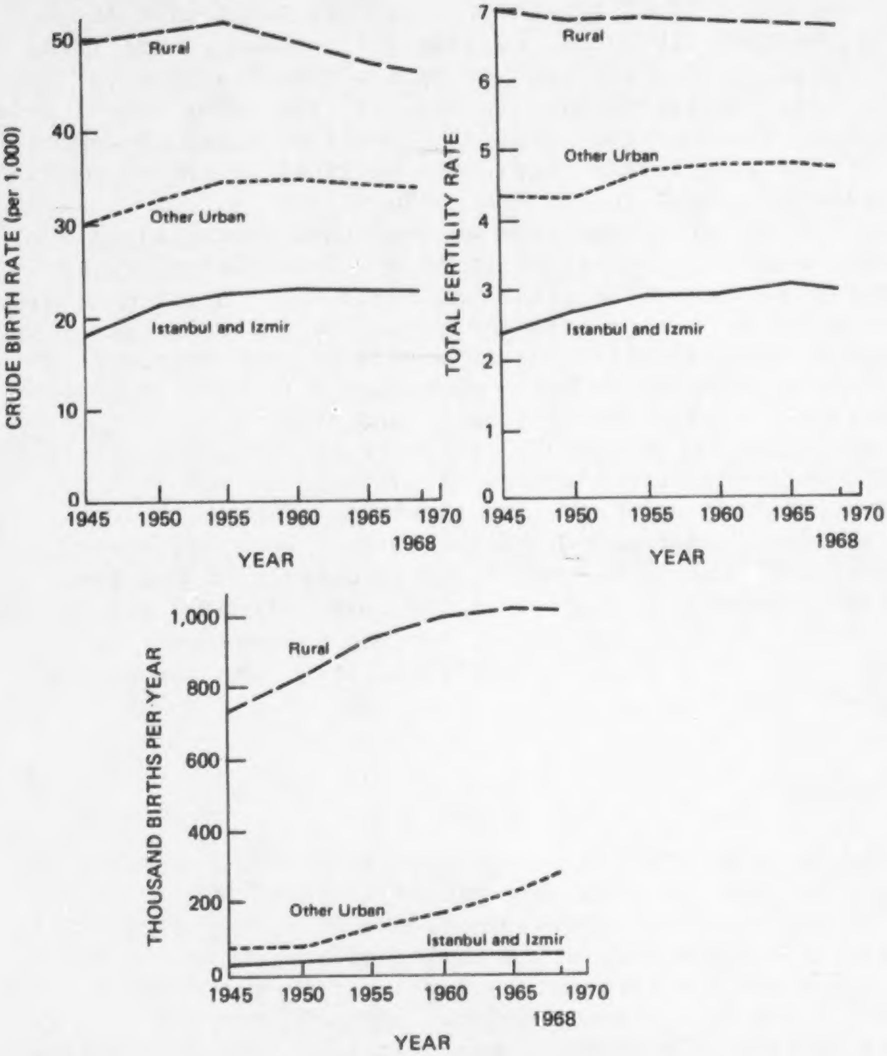


FIGURE 2 Crude Birth Rate, Total Fertility Rate, and Births by Rural-Urban Areas, 1945-68: Turkey

rural fertility at least double that of Istanbul-Izmir. Estimates by divisions for later dates are not possible with the available data.

The fertility of the national population could decline dramatically while the divisional levels changed little because the average fertility of families in the country as a whole is found by aggregating divisions of the population that changed in relative size. Prior to about

1950, the rate of growth of the urban population (due to all causes) was little different from that of the rural population, 2.5 percent per year compared with 2.1 percent, respectively. Thereafter, the urban growth rate jumped to a new and continuing level of around 6 percent per year, while the rural rate declined steadily, passing below 1 percent in the mid-1960s.

One of the connections between rural-urban migration and fertility is that the sons and daughters of rural parents move to the cities and have fewer children there than their parents' generation had in the villages. The cities have absorbed large numbers of people from rural areas without there being much change in average urban fertility, which was initially and still is much lower than rural fertility. Families of recent rural origin had more children than the original urban population, contributing to the slight elevation of overall urban fertility observed before the 1960s. However, downward fertility trends of various urban classes of population, including those of rural origin, are not ruled out by the observed overall elevation, because changes were taking place in the class composition of the urban population itself.

MORTALITY

The national decline in death rates probably reaches further back in time than can be captured by estimates for the 1935-75 period (see Figure 3). This at least is a good presumption, since the trend over those 40 years is downward, except for a rise in death rates during World War II. Although Turkey was not involved militarily, the material conditions of life deteriorated and there were a number of serious epidemics, both of which explain the reversal of trend.

For the late 1930s, various indices of mortality can be estimated only as orders of magnitude, due to the sparse nature of data for that period. The mortality indices can be estimated with greater confidence from the 1950s onward. On this understanding, life expectancy for both sexes combined appears to have risen from around 35 years in the 1950s to 59 years for the period 1970-75.

Infant and early childhood mortality is measured by the infant mortality index from the late 1940s up to the early 1970s. Estimates are reasonably strong from about 1960 onward and are acceptable indicators of national

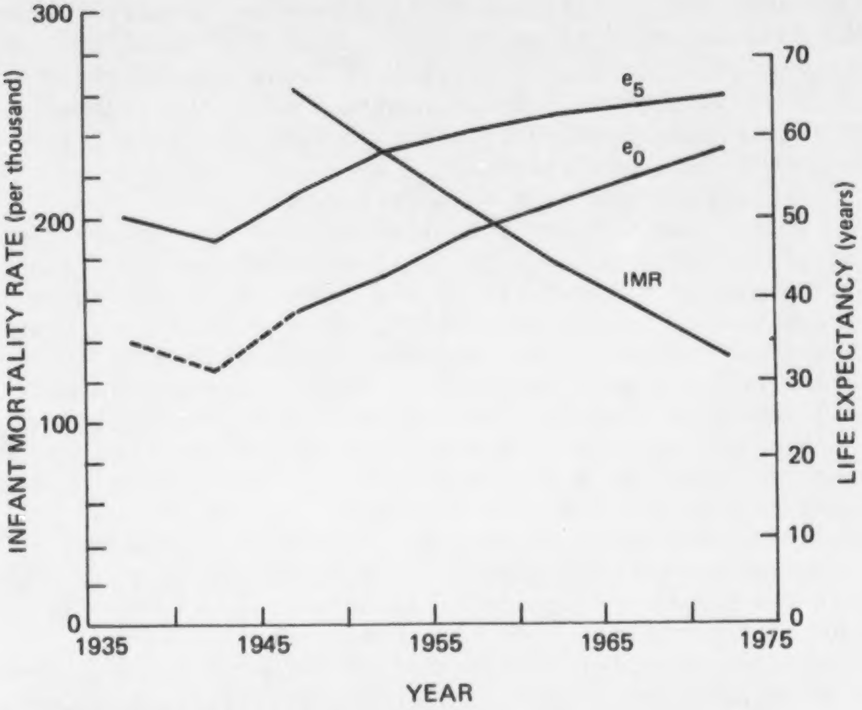


FIGURE 3 Mortality Measures for Both Sexes Combined, 1935-75: Turkey

Note: Dashed line shows that the estimate of e_0 was derived from e_5 by selecting split-model life tables to take the place of estimates for the IMR, which are unavailable for the earliest dates.

trends before that. Infant mortality declined from about 260 deaths per thousand births in the late 1940s to 126 per thousand in approximately 1973. The rate of decline does not seem to have changed much over the period, remaining near 3 percent per year.

In most populations that have as high an expectation of life after early childhood as in Turkey, the infant mortality rate would be around half the rate found in Turkey. The exact relationship varies considerably among countries, but there is no doubt that the infant mortality rate is exceptionally high in Turkey as compared historically and contemporaneously with other countries that have as low adult mortality as does Turkey. Whether the reduction of infant mortality has been held back by special disease factors, by unusual malnourishment, or by a general lag in infant and child care as compared with the health practices of adults, is an open question. The pattern of especially heavy infant mortality seems to apply to both sexes. Male infants have higher infant mortality than females by a margin similar to that found in many other populations.

The crude death rate is a less useful index of mortality than either life expectancy or the infant mortality rate, because it is affected markedly by age structure. Its level was on the order of 30 per thousand or a bit more in the late 1930s. It declined to a level of approximately 10 per thousand in the period 1970-75. As the proportion of population in the very lowest ages declines with falling birth rates, the persons subject to the highest age-specific death rates (infants) become less important as a source of deaths. Thus, part of the decline in the death rate is simply a reflection of declining fertility rather than declining mortality.

Infant mortality rates for divisions of the population were examined to estimate differentials and trends in those differentials (see Figure 4). Rural infant mortality was nearly twice that of Istanbul-Izmir in the late 1940s, with other urban places intermediate between the two. The differentials shrink over time, but infant mortality in rural areas was still almost two-thirds higher than in Istanbul-Izmir in the late 1960s. Estimates made separately by regions of the country suggest that there were sizeable differentials within the rural population in the late 1940s, but these regional differentials had largely disappeared by the late 1960s.

The decline of national infant mortality is connected with the divisional trends of infant mortality by the distribution of births among the divisions. As young adults migrate from rural to urban areas, the distribution of births shifts. Trends in the number of births by divisions show that urban births are increasing while rural births, though increasing at first, leveled off by the late 1960s. The rearing of proportionately more infants in urban family and community surroundings, which have lower risks of death than rural settings, contributes to the national decline.

POPULATION GROWTH

The trend of population growth in Turkey reflects births, deaths, and the international balance of migration (see

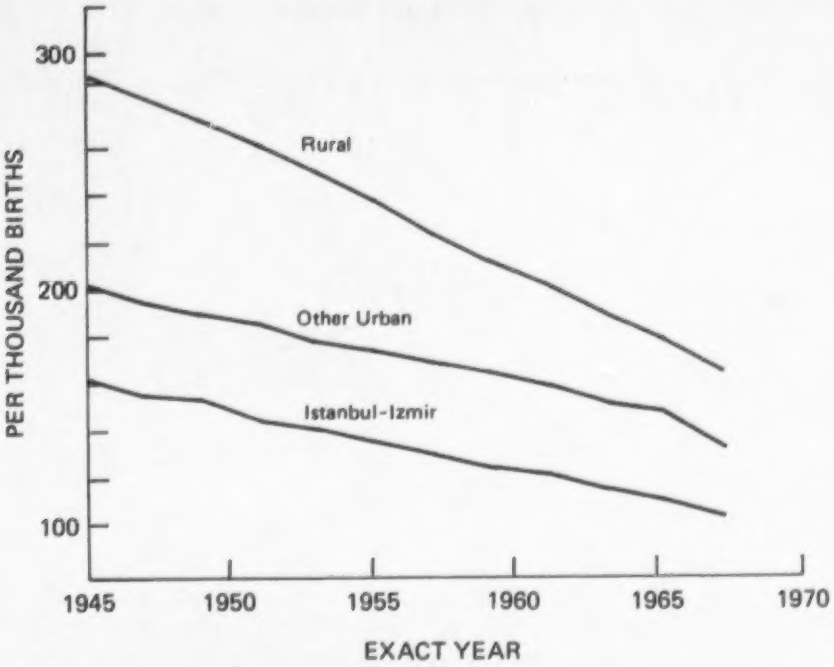


FIGURE 4 Infant Mortality Rates by Rural-Urban Areas, 1945-67: Turkey

Figure 5). The latter component was of little importance until the 1960s, when worker migration became a major economic factor with important demographic implications. Precise estimation of the volume of movements is impossible. There was a net loss of nearly one million persons from 1960 to 1975 (an estimate of 908 thousand is used in this report). The total number of Turks moving to other countries was some multiple of this figure, but many of these guest workers and their families returned to Turkey. In a population that was 40 million by 1975, the cumulative draw-down of the national population at home was not negligible. However, on an annual basis the effects on the total growth rate are rather moderate. The main components of population change over time are births and deaths.

The decline in mortality brought an increase in the growth rate, to a level averaging 2.8 percent per annum during the 1950s. Falling fertility and worker migration reduced the rate to approximately 2.4 percent per annum in the early 1970s. Declining fertility is a double-edged sword. Initially, it lowers the death rate through its

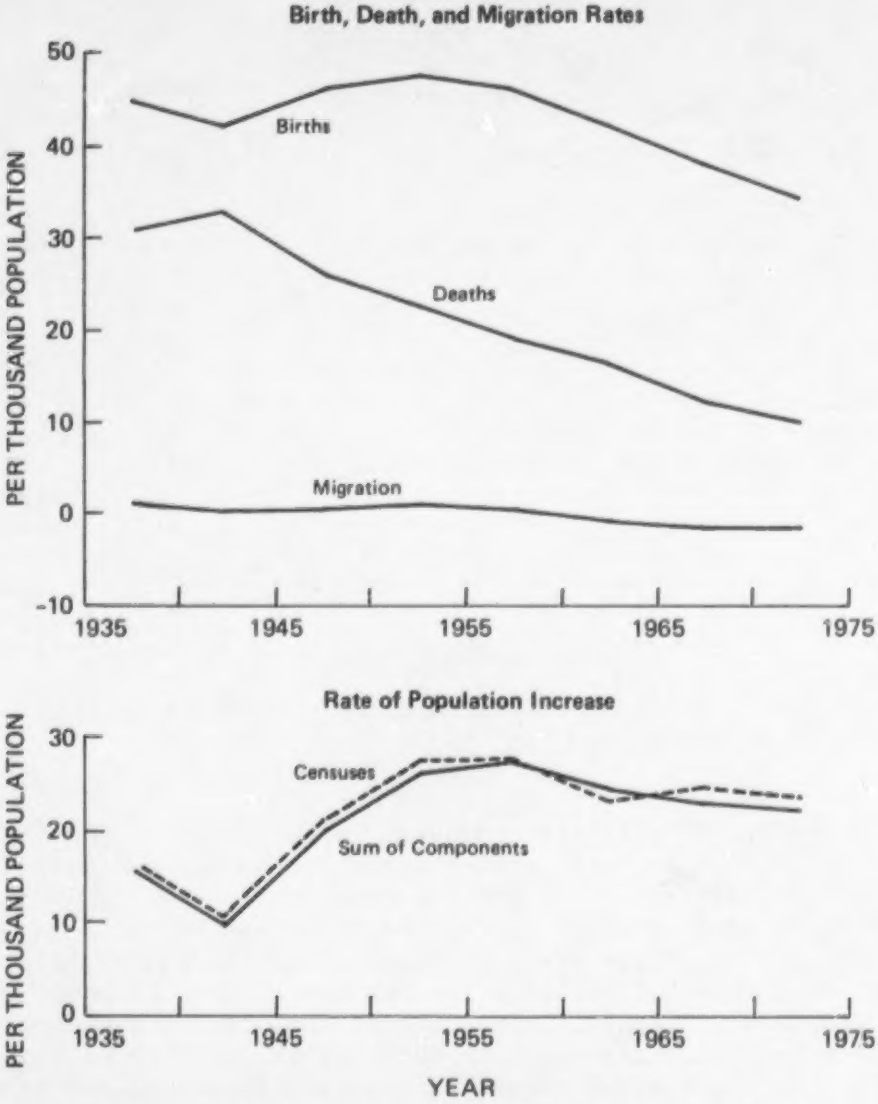


FIGURE 5 Overall Rate and Components of National Population Increase, 1935-75: Turkey

effects on the age structure at the same time as it lowers birth rates. The latter effect is, of course, the stronger one, and in time the effect on age structure disappears, due to aging of the reduced-size cohorts. Thus, the decline in fertility has not only brought a modest reduction in the growth rate, but has positioned the structure of the population for more decline in the future.

Combining estimates of the birth, death, and migration rates gives estimates of the total growth rate that are not much different from those estimated simply by comparing totals from one five-year census date to the next. This degree of consistency between the estimates of this report and the census-based growth rates is not altogether accidental, because the census data themselves play a major role in the estimation procedures. However, there are some important elements of independence between the two procedures for estimating the growth rate. Estimates for each component rest partially on independent data or on indirect techniques of measurement that are partially independent of changes in census coverage over time. Hence, general agreement of the sum of the components with the census growth rate is encouraging, but it is not conclusive assurance of accuracy.

1 Introduction

BACKGROUND

Turkey is the largest country in Western Asia, with a population of about 45 million in 1980. The country has extensive coastal areas on the Mediterranean, Aegean, and Black seas; extensive upland plains and hill areas including Central Anatolia; and rugged mountainous regions in the east and south. Turkey's political and territorial integrity date from 1923 when the Turkish Republic was founded. Fertility has declined in the past two and a half decades, but the extent of decline and the levels of recent fertility and mortality have not been estimated consistently by all observers.

Turkey has a variety of demographic data sources which have been used to estimate fertility and mortality levels and trends for the nation and for six divisions of the population. These data sources are reviewed in detail in this introductory chapter. Chapter 2 presents fertility estimates, Chapter 3 mortality estimates, and Chapter 4 discusses the cumulative effects of the various components of national population growth. Appropriate demographic techniques have been applied in constructing the estimates described below, among them a new technique called multiple reverse projection, which is described in detail in Appendix A. Appendix B describes a special technique used to estimate infant and early childhood mortality from birth-survival histories. Appendix C explains how census data were adjusted to correct for age misreporting, and Appendix D presents the available data on international migration from Turkey. Appendix E presents data on the population of six divisions of Turkey by age and sex as reported in the censuses from 1945 to 1970.

DATA SOURCES

Turkey conducted nine quinquennial censuses between 1935 and 1975. National-level data from the 1975 census are available only from a 1 percent sample of the census data, but more complete tabulations are available for the earlier censuses. Two national demographic surveys of the dual-record type have been conducted, the Turkish Demographic Survey of 1965-68 and a similar survey in 1974-75. Three national population surveys that included fertility histories and child-survival information were conducted in 1963, 1968, and 1973. A Turkey Fertility Survey was conducted in 1978 in collaboration with the World Fertility Survey, but those data were not available for use in this report.

Births in Turkey are registered for legal purposes, but the registration information is not cumulated for national statistical purposes and published. Death registration data for all district and province centers are available and these data sets have been examined. No death registration data are available for other cities or for villages. Also, fertility and mortality data are available from two special health training and research areas: the Etimesgut Rural Health District and the Yozgat (Province) Maternal, Child Health, and Family Planning Project.

Censuses

The first modern census was taken in 1927 but the series useful for demographic analysis begins with the report of the 1935 census. Turkey possesses an unbroken series of censuses from 1935 to 1975 at five-year intervals. The censuses were all taken at the same time of year and by essentially the same de facto counting procedures. Reports for the nine censuses are available in comparable detail for most years. Additional detail comes from the separate provincial volumes produced in 1935 and 1970. A 1 percent sample of the 1975 census is available, but the planned provincial volumes are incomplete and the national report was not available for use in this report. Questions on age and sex are tabulated in comparable five-year age groups for all dates at the national level; the results are summarized in Table 1. Marital status was not tabulated in 1940 and lacks standard five-year age groups above age 25 in 1950.

TABLE 1 Population of Turkey by Age and Sex as Reported in the Censuses, 1935 to 1975[a]
(in thousands)

Age	1935[b]	1940	1945	1950	1955	1960	1965	1970	1975[c]
Males									
0-4	1,454.8	1,387.0	1,288.4	1,585.1	1,985.5	2,184.7	2,359.3	2,661.7	2,765.2
5-9	1,230.2	1,419.0	1,350.1	1,338.5	1,677.0	2,076.9	2,418.8	2,611.0	2,795.7
10-14	862.7	1,190.0	1,286.5	1,275.6	1,295.8	1,691.2	2,061.1	2,363.4	2,728.7
15-19	567.8	829.7	1,050.0	1,271.3	1,248.3	1,249.9	1,548.6	1,924.7	2,314.2
20-24	761.4	524.5	790.0	990.9	1,210.2	1,178.2	1,213.1	1,496.6	1,833.1
25-29	632.1	684.6	484.9	727.0	959.5	1,157.5	1,056.7	1,108.2	1,452.3
30-34	594.0	618.6	732.1	524.3	749.0	1,028.3	1,140.4	1,019.2	1,092.6
35-39	494.4	590.5	608.1	688.4	519.5	749.7	999.1	1,117.4	1,034.3
40-44	328.9	466.4	543.0	552.0	666.8	506.0	705.8	921.5	1,095.2
45-49	246.9	303.3	401.8	499.8	525.0	610.4	446.2	644.7	903.6
50-54	229.5	248.2	283.2	389.6	505.4	548.5	613.1	457.1	654.5
55-59	164.8	175.2	171.3	214.3	327.2	424.7	450.2	497.1	388.8
60-64	178.2	190.2	200.1	197.1	243.1	369.0	453.5	476.5	517.5
65-69	101.9	100.1	98.8	114.5	126.4	166.5	258.3	321.6	353.4
70-74	92.5	83.1	80.1	77.3	98.5	113.9	145.9	220.9	261.9
75+	89.4	88.1	78.1	81.3	96.3	108.5	126.8	165.4	226.2
Subtotal	8,030	8,899	9,447	10,527	12,233	14,164	15,997	18,007	20,417

Females

0-4	1,318.2	1,258.0	1,186.5	1,509.3	1,879.4	2,078.9	2,264.8	2,594.8	2,652.5
5-9	1,146.3	1,266.0	1,244.1	1,238.3	1,562.0	1,927.7	2,252.3	2,484.0	2,665.9
10-14	758.0	991.2	1,075.6	1,082.2	1,090.6	1,488.5	1,812.3	2,167.3	2,495.7
15-19	493.7	698.9	932.7	1,119.7	1,088.1	1,059.2	1,365.8	1,770.7	2,160.2
20-24	650.5	518.6	692.6	974.2	1,111.1	1,127.9	1,134.5	1,355.5	1,713.9
25-29	732.9	705.9	620.0	752.6	1,021.7	1,177.3	1,162.6	1,154.0	1,394.4
30-34	652.4	715.9	700.6	591.3	731.3	985.8	1,135.9	1,165.7	1,098.9
35-39	517.8	568.7	579.2	600.7	525.8	693.8	935.8	1,097.3	1,141.3
40-44	481.6	530.7	558.8	595.9	621.5	548.4	677.7	900.0	1,065.8
45-49	319.9	348.4	379.0	445.8	473.1	500.0	430.1	564.1	826.0
50-54	390.6	416.5	434.7	472.0	528.2	581.3	591.6	516.3	645.3
55-59	198.4	217.3	219.7	260.5	308.8	369.4	415.6	440.6	392.3
60-64	302.2	327.4	349.7	359.2	387.3	461.4	502.1	529.9	551.8
65-69	106.6	114.1	124.8	154.4	172.8	213.8	271.5	319.4	370.4
70-74	128.1	131.2	133.2	138.2	171.2	195.7	221.0	265.5	298.0
75+	119.9	114.1	112.4	125.8	158.5	188.1	220.9	273.2	308.1
Sub-total	8,317	8,922	9,344	10,420	11,831	13,591	15,394	17,598	19,780
Total	16,347	17,821	18,790	20,947	24,065	27,755	31,391	35,605	40,198

Note: Numbers add correctly to totals; rounding of age groups and of totals independently gives the appearance of different totals.

[a] Persons with ages reported as unknown were redistributed in proportion to the number of persons in each age group at each census.

[b] Adjusted from 16,158 to 16,347 to correspond with national boundaries after the annexation of Hatay in 1939.

[c] Preliminary data from a one percent sample of the 1975 census.

This rich series of censuses implicitly contains the history of mortality and fertility for Turkey except for changes in population due to territorial change or international migration. The only territorial change between 1935 and 1975 was the annexation of Hatay Province in 1939. International migration became an important influence on population size and age structure with the worker movements of the 1960s and 1970s. Information with which to assess recent migration is available from special surveys by the State Planning Organization and the censuses of the principal worker-receiving country, the Federal Republic of Germany. For earlier periods, special studies on population exchanges of minor demographic significance are available.

For subdividing the population into rural-urban and geographic divisions, data are available between 1945 and 1970 on age, sex, and marital status, classified by places with populations above and below 10,000. These data are available either from census reports (1970) or from the archives of the State Institute of Statistics. Demographers who have copied information from the archives and placed it in computer-readable form kindly made these materials available.

The 1965 boundaries of provinces were used as the standard for aggregating data by the six geographic rural and urban divisions. Adjustments for changes in boundaries prior to 1965 were made with information from Kemal Ozok's meticulous compilation (Turkey, Regional Planning Office, 1968). There were no further changes in province boundaries after 1965, so the six divisions for 1970 have the same boundaries as 1965 and the adjusted data for earlier dates. For some years, data on marital status by sex and five-year age groups are deficient below the national level. However, data are sufficient to compile age-sex distributions for 1945-70.

The 1970 and 1975 censuses asked about the cumulative fertility of ever-married women (total number of children born alive) and the survival status of their children (total number of children still living). These data are valuable for indirect estimation of infant and early childhood mortality when the tabulations include (1) numbers of children ever born and numbers surviving, cross-classified by five-year age groups of mothers from 15 to 34; and (2) distributions of all women by marital status by at least the same five-year age groups. Matching tabulations of (1) and (2) are available at the national level for 1970 and for the 1 percent sample of the 1975 census. The necessary coordination between tabulations of types (1) and (2) was not fully achieved for the rural-urban division of population in 1970 because province-level tabulations of type (1) refer to the administrative definitions of rural and urban, whereas those of type (2) refer to places with populations under and over 10,000. The second method of distinguishing rural and urban is preferable because it matches the dividing criterion used for age and sex distributions for Turkish censuses. Reports for provinces from the 1975 census are incomplete; some province reports show age and sex by the 10,000-population division of rural and urban, but they do not include any tabulations of types (1) and (2).

The 1970 and 1975 censuses also asked a question about the number of children born alive who died before reaching age 1. This question does not provide a reliable basis for infant mortality measurement, because misreporting of age at death is severe and the time in the past to which the mortality experience refers is unclear. In its place, the Panel suggests using a question on whether each ever-married woman had a live birth during the last year. The new question would provide a basis for estimating the current age pattern of fertility, provided it is tabulated by ages of mother in five-year age groups. In combination with other census data, this question would help to provide estimates of fertility levels in terms of crude birth rates and total fertility.

National Dual-Record Demographic Surveys

The Turkish Demographic Survey (TDS) was conducted between 1965 and 1968 by the School of Public Health in the Ministry of Health. A national area sample of 40,000 households was used to collect data on births, deaths, migrations, and population structure. The TDS used a monthly recording system and a semi-annual independent survey. Thirteen rural and urban subdivisions of the population were defined and brought into the national sample sequentially until all units were simultaneously under surveillance by June 1966. Complete national data are available for 1966-67 (Turkey, School of Public Health, 1970). The TDS estimates of birth and death rates are made by standard dual-record methods that include an estimate of omissions by both record systems.

In 1974, a second-generation TDS called the Turkish Population Survey (TPS) was started in the State Institute of Statistics. Its first report, for 1974-75, is available (Turkey, State Institute of Statistics, 1978), but the procedures for data collection and processing are not sufficiently well documented to permit an evaluation of the results. Consequently, these data were not used in this report.

National Population Surveys

The Ministry of Health held a national population survey in 1963, which included both a representative demographic sample of approximately 8,000 ever-married women and a subsample of 2,600 currently married women. Questions on contraceptive knowledge, attitudes, and practices were the main purpose of the subsample. Data concerning marital fertility and early childhood mortality from the 1963 demographic sample of 8,000 women are available.

In 1968, a representative national sample of 3,300 currently married women was interviewed in the Survey on Family Structure and Population Problems of the Institute of Population Studies of Hacettepe University. This included information on the fertility of currently married women, comparable to the 1963 survey. The same fertility questions were included in a third national survey of 4,600 currently married women conducted by the Hacettepe Institute in 1973.

Reports and tabulations from the 1968 and 1973 surveys are available for the country as a whole and for subdivisions that differ somewhat from the six population divisions used by the Panel. Special tabulations of birth histories and the survival of the children are available according to the Panel's six divisions from the 1968 and 1973 surveys. Of the two, only the 1968 tabulations are accompanied by sufficient information about the preparatory data processing to allow them to be evaluated. The 1968 data were therefore judged to be more useful and were used as one basis for estimating child mortality trends (see Chapter 3).

Birth and Death Registration

Birth registration is required in Turkey, and most persons have birth cards. However the system is not used to generate national statistics on birth events. Death registration is also required. Death statistics are gathered from the registration system by the Ministry of Interior for all cities and towns that are provincial or district headquarters. These data are published by the State Institute of Statistics. An evaluation by Kadir Sumbuloglu for 1960 to 1975 shows that underenumeration of deaths varies among cities and at different dates with no detectable systematic pattern that would permit adjustment. There is, in addition, differential omission of infant deaths (Sumbuloglu, 1978).

National Life Tables

A Turkish national life table is available based on data from the Turkish Demographic Survey. Life tables of apparently sound quality are also available for a nine-year period from the Etimesgut Rural Health District (population of 80,000 persons) and from the Yozgat provincial health project (population of 500,000 persons), which utilized a dual-record sample of 50,000 persons (Institute of Community Medicine, 1975; Tekce, 1979).

2 Fertility

NATIONAL CRUDE BIRTH RATES, 1935-75

A common technique for estimating fertility is reverse survival. In this report a more refined reverse survival alternative is applied. The following sections describe the general technique, the alternative used here and resulting estimates of crude birth rates. Estimates of crude birth rates by other means are also compared.

The General Technique of Reverse Projection

Measures of fertility for the years preceding a census can be estimated by projecting in reverse the number of persons at different ages at a given time before the census. Thus, the crude birth rate _t_ years before the census may be estimated by reverse projection to birth of the number of persons aged _t_ at the time of the census, combined with reverse projection of the whole population to determine the appropriate denominator for the birth rate _t_ years before the census.

The accuracy of an estimate of fertility for a particular time period derived by reverse projection depends on how well the projection allows for the actual change in the populations that form the numerator and denominator of the crude birth rate and on how accurately the census recorded the subgroups that were projected to form the numerator and denominator of the fertility measure. Since the birth rate is a ratio, however, equal proportionate errors in counting or projecting the two groups that form the numerator and denominator (for example, a 5 percent undercount of both populations or a 2 percent overstatement of the proportion surviving in each group) would still allow an accurate estimate of the birth rate. Therefore, changes in the extent of coverage from one census to the next, which has been a problem in Turkey, do not bias the fertility measure provided the under- or overenumeration is proportionate across the age groups used in calculating the numerators and denominators of the fertility measures.

Misreporting of age, which moves individuals from one age (or age group) to another, causes spurious intertemporal variation in fertility estimates derived by reverse projection. For example, systematic overstatement of age such that the true number of people under age 5 is understated and the number in the next age group (5-9) is overstated, creates the appearance of a decline in fertility from the period 5 to 10 years ago to the period 0 to 5 years ago. In Turkey, there is systematic age misreporting of the pattern just described. If the age distribution is distorted by age misreporting in the age groups that are projected, the trends of fertility that are estimated will be spuriously erratic.

The Turkish censuses extend backward in time from 1975 to 1935 at nearly exact five-year intervals. The data they provide are ideal for making estimates of fertility through reverse projection as long as appropriate assumptions about mortality can be made and the problems created by age misstatement can be overcome. Chapter 3 explains how mortality estimates were made to meet this first requirement. The solution to the other problem, that of age misstatement, may be approached in two different ways.

One approach is to adjust the censuses data for age misreporting. No attempt to correct for general coverage errors is necessary, because this type of error, as already explained, does not affect reverse-projection estimates of the crude birth rate. The method used to make these corrections for the Turkish censuses is explained in Appendix C. However, no known method is capable of eliminating all error due to age misstatement. The resulting reverse projections of fertility from a census adjusted for age misreporting are imperfect to the same extent.

Multiple Reverse Projection (MRP)

An alternative approach, suggested by Frederic Shorter, is called "multiple reverse projection" (MRP). Described in detail in Appendix A, this method has also been applied to the Turkish censuses. From each census, a time series of estimates of fertility is constructed by reverse projection. The series goes back in time from the date of the census as far as assumptions based on mortality estimation are warranted. This procedure gives fertility estimates for years _t_ to _t_+5 years before the census, based on births whose survivors are in the age group _t_ to _t_+5 of the census. For example, the births for the period 20 to 25 years before the census are calculated from the age group 20-25 in the census. The denominator of the crude birth rate is an estimate of the total population size during the same period 20 to 25 years before the census, which is also given by the reverse projection. When a sequence of censuses is available, an independent time series of fertility estimates can be calculated from each census.

In all reverse projections, there is a theoretical problem concerning how to "close" the population at the uppermost ages. In actual data the uppermost age group is an open-ended interval. For example, the Turkish data are divided into five-year age groups up to age 75 with an open-ended interval of "75 and over" as the last group. The population in this open age group consists of persons who were ages 70-74 and 75+ five years earlier. In order to use the survival rates of the life table to project backward in time, it is necessary to know how the population was divided between individuals less than 75 (those in the 70-74 age group) and those who were already 75 or over. Assumptions can be made and the errors in those assumptions will have little effect on a crude birth rate only five years earlier, because population size, the denominator of the crude birth rate, will be affected very little by the error. However, as the reverse projection extends further backward in time, errors in population size due to such assumptions are magnified and can create misleading results.

The multiple reverse projection method offers a simple solution that makes use of the data from prior censuses. While the total size of these prior censuses may not be correct, the relationship between the size of the open age interval and the next lower age interval can be accepted. That relationship is based on actual census data and reflects all the conditions of fertility, mortality, and migration in the past that have influenced the distribution by age at the uppermost ages. Multiple reverse projection uses this information from prior censuses to "close" the reverse-projected age distribution at the highest ages.

For Turkey, a series of crude birth rates from 1935 to 1975 was calculated from the 1975 census, a series from 1935 to 1970 from the 1970 census, and so on. Thus, eight independent estimates of the crude birth rate were made by reverse projection for the time period 1935-40, seven for 1940-45, and so on, creating multiple estimates for each five-year period. They vary among themselves for a given period to the extent that age misreporting has distorted the different age groups that are the basis of the single estimates. However, a shortage of persons in one age group due to age misstatement necessarily means an excess count of persons in another age group. When the age misreporting pattern is stable from one census to the next, the shortages and excesses occur in the same age groups in every census. Hence, birth rates for a given period that have been estimated from a series of censuses are based partly on overstated age groups and partly on understated age groups. Upward error due to age error in one census is matched by downward error in another census. Therefore, a strong estimate of the crude birth rate for a particular period is an arithmetic mean of the multiple estimates for the period.

Gains and losses in population due to migration in the past affect the number of survivors shown in the current age distribution. Therefore, migration must be included as one of the determining components of the reverse projection if migration is significant. During the 1960s and 1970s, worker migration to Europe became an important demographic influence in Turkey. Earlier there were smaller movements, principally as Turks in the Balkan countries relocated in Turkey. Estimates of migration were constructed independently from the reverse projection (as described in Appendix D), then introduced as component determinants of the reverse projection. The available distributions of migrants by age are only approximate, which causes distortions in the reverse-projected cohorts. These errors are similar to those of age misreporting and are mutually offsetting in the context of multiple reverse projection.

MRP Estimates of Crude Birth Rates

Multiple reverse projection was applied to the Turkish censuses first without any adjustment for age misreporting, and then with adjustment. The resulting estimates of the crude birth rate, shown in Table 2, were then averaged for each period of estimation. For every period of estimation from 1935 to 1975, the average estimates based on corrected and uncorrected age data are almost identical, except for the last, 1970-75. The reason for such excellent agreement is that the errors of estimation caused by age misreporting are offsetting errors. A valuable conclusion from this comparison is that the Turkish estimates of the crude birth rate do not depend upon the accuracy of adjustments for age misreporting. Indeed, robust estimates of the crude birth rate can be made without going through the prior step of correction for age misreporting.

The success of the method without adjustment being needed for age misreporting depends upon having more than one census from which to make estimates of the birth rate for a period. If data from only one census are used, the estimate of births for five years prior to that census typically lies below an estimate from multiple censuses (see Figure 6), because the 0-4 age group is understated by age misreporting. Single-census estimates of the

TABLE 2 National Crude Birth Rates, 1935-75, Estimated by Multiple Reverse Projection: Turkey

Period of Estimation	Census Year								Average of All Possible Censuses	Number of Reverse Projections
	1975	1970	1965	1960	1955	1950	1945	1940		
Part A. Estimates Based on Reported Age Distributions										
1935-40	46.5	45.1	44.2	44.5	45.4	46.2	50.0	44.7	45.8	8
1940-45	43.1	42.8	43.4	42.0	43.7	47.0	41.2	--	43.3	7
1945-50	45.0	44.3	44.9	48.5	49.4	43.9	--	--	46.0	6
1950-55	46.3	48.1	50.0	50.7	46.4	--	--	--	48.3	5
1955-60	47.9	48.5	49.2	42.4	--	--	--	--	47.0	4
1960-65	46.0	44.8	38.9	--	--	--	--	--	43.2	3
1965-70	40.0	37.6	--	--	--	--	--	--	38.8	2
1970-75	33.0	--	--	--	--	--	--	--	33.0	1
Part B. Estimates Based on Age Distributions Corrected for Age Misreporting										
1935-40	45.6	43.9	44.5	45.3	45.9	45.3	47.3	46.8	45.6	8
1940-45	41.9	43.0	44.2	42.1	42.6	44.6	43.0	--	43.1	7
1945-50	45.2	44.9	45.1	47.2	47.3	45.7	--	--	45.9	6
1950-55	46.9	48.1	48.7	49.0	48.4	--	--	--	48.2	5
1955-60	47.9	47.2	47.7	44.3	--	--	--	--	46.8	4
1960-65	44.7	43.4	40.7	--	--	--	--	--	42.9	3
1965-70	38.6	39.3	--	--	--	--	--	--	39.0	2
1970-75	34.5	--	--	--	--	--	--	--	34.5	1

Note: Rates are per thousand.

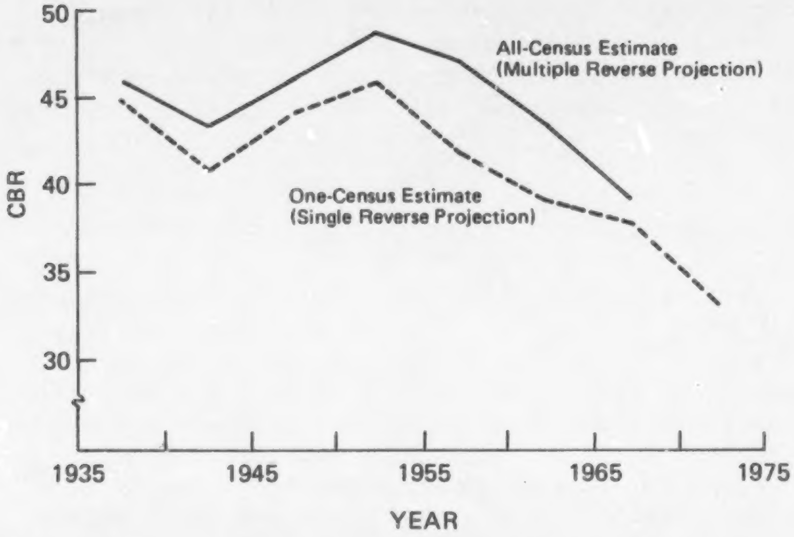


FIGURE 6 Estimates of Crude Birth Rate Based on Reported Age Distribution from One Census at End of Five-Year Period and Estimates Based on Distribution from all Available Censuses, 1935-75: Turkey

birth rate, therefore, are vulnerable and not acceptable. The extent of understatement by comparison with estimates from more than one census varies with age misstatement. Taking all multiple-census estimates (two or more), they average 5.9 percent higher than the single-census estimates, with a standard deviation of 3.5. If this degree of understatement is accepted as typical, an acceptable way to estimate the crude birth rate for 1970-75 is to raise the estimate based on one census of 33.0 per thousand by 5.9 percent to 34.9 per thousand. The result is then subject to a range of error of ± 1.2 per thousand population.

Other Estimates

Independent confirmation of the trend in crude birth rates can be sought in other estimates of the crude birth rate that are available for the periods 1955-60, 1966-67, and approximately 1970, each based on different types of data or methods. In the next section, total fertility rates are derived from the crude birth rate and also compared with independent estimates. This procedure provides further checking of the crude birth rate by confirming its implications.

The birth rate for 1955-60 was estimated by Demeny and Shorter (1968) using two different methods of indirect estimation:

Demeny-Shorter (1)

The first method calculated the natural intercensal rate of increase from the migration-adjusted census totals for 1955 and 1960. The death rate was then added to this to produce the birth rate. To determine the death rate, deaths above age 5 were calculated from model life tables; death rates from the table were multiplied by the mid-period census population in each age group. The model life table was selected using the intercensal forward-projection procedure (described in Chapter 3). Below age 5, the death rate was taken from a life table selected by the Brass child mortality method, using data from the 1963 national sample survey. (The Brass method is explained in Chapter 3.) There are two child mortality estimates (I and II) that describe the acceptable range. The crude birth rates for 1955-60 found by this approach were 46.6 (I) and 44.7 (II) per thousand.

Demeny-Shorter (2)

The second method used the reported population under age 10 from the 1960 census to make a single reverse projection. Since the errors in the two five-year age groups below age 10 proved to be offsetting (see Appendix C), the reported proportion of total population under age 10 is relatively accurate. For the reverse projection, the two child mortality estimates mentioned above (I and II) were used to obtain two alternative estimates. Alternative birth rates were calculated with the aid of tabulated stable populations (Coale and Demeny, 1966). A model life table was chosen on the basis of the $_2q_0$ value (proportion dying up to age 2); then the birth rate associated with a given proportion under age 10 was found from the tabulated stable population based on that model life table. This is an efficient and only trivially biased method for making reverse projections over short periods of time. Moreover, the method is not sensitive to the selection of a particular family of life tables so long as mortality is within the range of "normal" variation. Because Turkish mortality is strongly deviant (see Chapter 3), this characteristic imparts a slight downward bias to estimates of the birth rate derived by this method.

The common element of the two Demeny-Shorter methods is the estimate of mortality rates under age 5, which has two alternative values. The reliance on alternative child mortality rates (CMR) is noted below. As a result, two different measures of the crude birth rate (I and II) are produced for each indirect method of estimation. In other respects, methods (1) and (2) rely on different data and to that limited extent the estimates they produce are partially independent. The results for 1955-60 are crude birth rates as follows:

Method of Estimation	Estimate I (High CMR)	Estimate II (Low CMR)
1. Components of population change between two censuses	46.6	44.7
2. Reverse projection by tabulated models from a single census	46.3	44.5

A 1 percent sample of the 1975 census provides a basis for estimating the crude birth rate around 1970 using the second Demeny-Shorter method explained above (Özbay et al., 1977). The census included questions on number of children ever born and surviving; hence, an indirect estimate of child mortality could be calculated from the census itself, utilizing the Brass-Trussell method explained in Chapter 3. The proportion of the population under age 10 in the 1975 census was used for the single reverse projection. The resulting estimate of the crude birth rate is 35.8 per thousand. Since the mortality information on which this estimate is based refers to about 3.1 years before the census on average, and the information on survivors of births refers to a ten-year period prior to the census, there is an imperfect match of dates for the parameters. The birth rate estimate refers to a date circa 1970.

Turkish Demographic Survey Estimates

For 1966-67, the Turkish Demographic Survey (TDS) provides a preliminary estimate of 37.3 per thousand for the crude birth rate. The estimate is from a national household demographic survey conducted as part of a dual-record statistical system, in which births were found by both monthly visits and half-yearly surveys. When the dual-record methodology (see glossary) is applied, there is an upward adjustment for birth events missed by both systems; the final TDS estimate of the crude birth rate for 1966-67 is 39.6 thousand.

Estimates Based on National Fertility Surveys

The national surveys of the fertility of married women conducted in 1963, 1968, and 1973 do not provide a robust basis for the independent estimation of crude birth rates. The reasons are two: the sample size of the surveys is too small to allow the estimation of annual rates from only one year of events, and a number of design features place limits on how the data can be used.

Table 3 summarizes the CBR estimates derived from the various estimation procedures described above.

TABLE 3 Summary of National Crude Birth Rate Estimates, 1935-75: Turkey

	Period of Estimation							
Method of Estimation	1935-1940	1940-1945	1945-1950	1950-1955	1955-1960	1960-1965	1965-1970	1970-1975
Multiple Reverse Projection								
Reported age distribution	45.8	43.3	46.0	48.3	47.0	43.2	38.8	34.9[a]
Corrected for age misreporting	45.6	43.1	45.9	48.2	46.8	42.9	39.0	34.5
Demeny-Shorter (1)								
CMR I	--	--	--	--	46.6	--	--	--
CMR II	--	--	--	--	44.7	--	--	--
Demeny-Shorter (2)								
CMR I	--	--	--	--	46.3	--	--	--
CMR II	--	--	--	--	44.5	--	--	
1975 Census	--	--	--	--	--	--	--	35.8[b]
Turkish Demographic Survey	--	--	--	--	--	--	39.6[c]	

[a] Based on a single-census estimate that is adjusted as explained in the text.
[b] Circa 1970.
[c] 1966-67.

NATIONAL TOTAL FERTILITY RATES, 1935-75

The trend of the crude birth rate (Table 3 and Figure 1) gives a less than complete description of the onset of fertility decline in Turkey. The age structure of the Turkish population was seriously scarred by excess infant and adult mortality during the Balkan wars and Turkey's own war of independence, which ended in 1922. Female birth cohorts affected by these events were passing through their childbearing years as late as the 1960s. These true irregularities of age and sex composition have themselves affected crude birth rates separately from the general trend of declining childbearing rates. It is useful, therefore, to evaluate the trend of fertility from the standpoint of the total fertility rate.

The total fertility rate describes the average total number of children born to a woman according to the current age-specific fertility rates (see glossary). Since the number of births in any year depends upon the number of women in each childbearing age group as well as on the age-specific fertility rates, there are two factors underlying the crude birth rate. The total fertility rate isolates and measures only the fertility component, leaving aside the effect of changes in age and sex distribution.

The following substitution procedure is used to calculate the total fertility rate (T) that implies the same number of births (B) as the crude birth rate:

$$T = 5 \cdot \sum_{i=1}^{7} \left[\frac{B}{B^*} \cdot F_i^* \right] \text{ where } B^* = 5 \cdot \sum_{i=1}^{7} \left[F_i^* \cdot \overline{W} \right]$$

W refers to the proportion of women in an age group i in the total population (both sexes), and F_i^* refers to a standard fertility distribution by age for the population in question. The age pattern, but not the level, of this fertility schedule determines T.

Standard Fertility Schedules

Any reasonable choice of fertility schedule provides a satisfactory basis for deriving the total fertility rates from crude birth rates. For Turkey, data are available to make this choice with some precision. A standard distribution of age-specific fertility is constructed from data on age-specific marital fertility and proportions married by age. Marital fertility schedules are available from national sample surveys (Table 4), and marriage proportions are available from the censuses (Table 5).

The marital fertility schedule for Turkey (shown in Figure 7) has a shape that characterizes populations practicing fertility control by contraception. When compared with a natural fertility schedule (one with no deliberate control), there is a noticeable clockwise rotation. This difference is due to birth limitation during the older ages of marriage. The rising trend of contraceptive control in Turkey is also confirmed by independent data on the prevalence of contraceptive use

TABLE 4 Percentage National Distribution by Age of Marital Fertility, 1963-73, Compared with a Schedule of Natural Fertility: Turkey

Age Group	Natural Fertility	National Sample Surveys			
		1963	1966-67	1968	1973
15-19	18.4	20.8	20.0	19.0	21.5
20-24	21.0	24.7	24.7	23.5	25.8
25-29	19.8	20.6	21.0	20.7	21.6
30-34	17.8	16.5	16.5	16.6	15.8
35-39	14.4	11.8	11.9	13.1	10.9
40-44	7.5	4.6	5.0	6.2	3.6
45-49	1.1	0.9	1.0	1.0	0.7
Total	100.0	100.0	100.0	100.0	100.0

Sources:

1963: Ministry of Health survey. Marital fertility is available from reports of births during the last year by mothers aged 15-44. Original data are extended by extrapolation to the 45-49 age group. An age adjustment is made to match age with births occurring an average of 6 months before the survey.

1966-67: Turkish Demographic Survey. Births are available by age of mother at time of birth. The numbers of married women are available for five-year age groups only up to age 24 and for ten-year age groups thereafter. Marital status information from the censuses of 1965 and 1970 was used to split the ten-year age groups. The fertility rate for ages 45-49 was extrapolated.

1968: Hacettepe survey; same type of data as in 1963.

1973: Hacettepe survey; same type of data as in 1963 and 1968. A direct estimate is available for the age group 45-49.

Natural Fertility Schedule: This is a standard schedule from Coale, Hill, and Trussell (1975).

TABLE 5 National Proportions of Females Married by Age, from 1935-75 Censuses: Turkey

Age Group	Census 1935	1940	1945	1950	1955	1960	1965	1970	1975[a]
15-19	.232	(.245)	.258	.313	.396	.333	.273	.247	.213
20-24	.802	(.796)	.790	.822	.848	.839	.827	.794	.749
25-29	.910	(.910)	.910	(.912)	.913	.941	.940	.931	.915
30-34	.911	(.914)	.916	(.915)	.914	.946	.954	.953	.942
35-39	.877	(.886)	.895	(.904)	.912	.933	.940	.948	.940
40-44	.768	(.799)	.830	(.851)	.872	.893	.904	.918	.913
45-49	.653	(.706)	.758	(.790)	.822	.855	.860	.879	.878

Note: Parentheses indicate that data are not available. Estimated values were inserted by linear interpolation between adjacent pairs of censuses.

[a] Based on a 1 percent sample of census data.

(Table 6). Studies of trends in the types of contraceptives that are used show, in addition, that progressively more effective methods are being used (Fisek, 1978).

It could be assumed that the marital fertility pattern in Turkey in the 1930s was not much different from a natural fertility pattern, and that it changed primarily after the post-war period (from 1945-50 onward), moving linearly to the 1963 and 1973 schedules. If these assumptions are accepted, Turkey would be described as having a changing pattern of marital fertility that follows the clockwise rotation noted above.

Total Fertility Rates

The multiple-reverse projections play a role in estimating total fertility rates (TFR) by providing estimates of the W values in Equation 1 (proportions of women in the populaton belonging to each age group), and by giving the numbers of births, B. A changing marital fertility pattern was assumed for the schedules of F_i^*, with results as follows:

Period	TFR
1935-40	6.66
1940-45	6.55
1945-50	6.85
1950-55	6.54
1055-60	6.54
1960-65	6.10
1965-70	5.63
1970-75	5.05

Alternatively, a single marital fertility standard, based on the 1963 pattern, could be assumed. The results of the two alternatives are shown in Figure 8. The assumption of a changing pattern is accepted as the most reasonable basis for calculating trends in the total fertility rate, but the range of possible overstatement of the total fertility level for the earlier years is

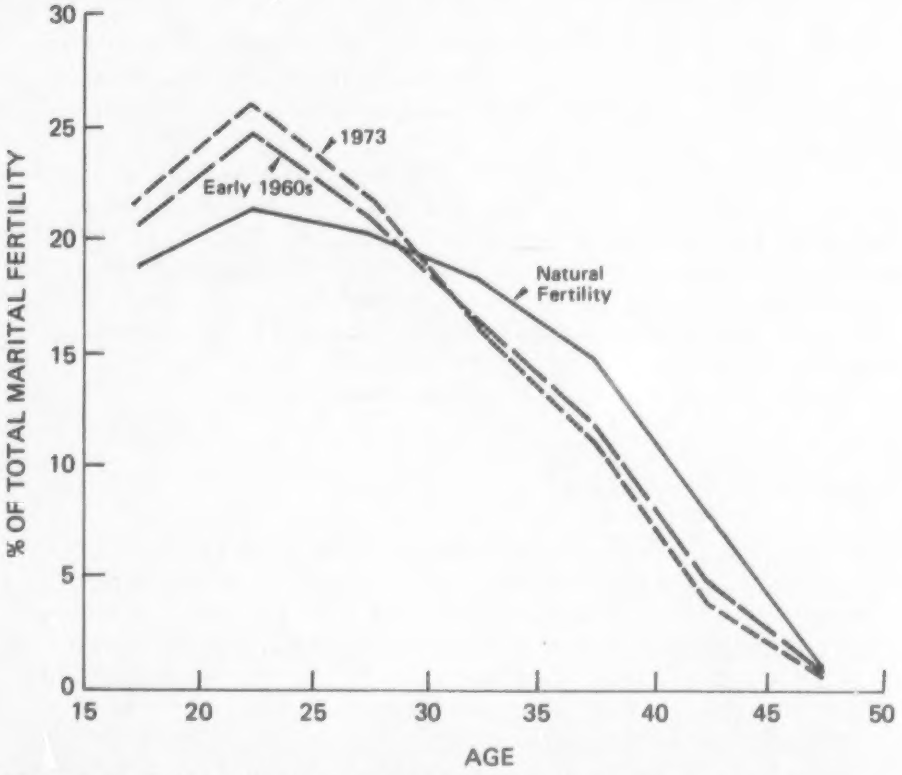


FIGURE 7 Distribution by Age of Marital Fertility Under Natural and Controlled Conditions, Early 1960s and 1973: Turkey

TABLE 6 National Proportions of Married Women Currently Using Some Method of Contraception by Age Group, Derived from National Sample Surveys in 1963, 1968, and 1973: Turkey

Part A. Number of Married Women Currently Using Some Method of Contraception (per thousand)

Birth Cohorts	Age at Interview <20	20-24	25-29	30-34	35-39	40-44
1919-23	--	--	--	--	--	175[a]
1924-28	--	--	--	--	241	320[b]
1929-33	--	--	--	279	369	314[c]
1934-38	--	--	259	416	442	--
1939-43	--	153	303	458	--	--
1944-48	89	247	435	--	--	--
1949-53	160	281	--	--	--	--
1954-58	160	--	--	--	--	--

Part B. Number of Respondents by Age Group

Sample Survey	Age Group <20	20-24	25-29	30-35	35-39	40-44
1963	143	435	577	598	452	350
1968	294	639	658	616	659	414
1973	342	819	774	709	839	649

[a] Diagonal shows estimates from 1963 survey.
[b] Diagonal shows estimates from 1968 survey.
[c] Diagonal shows estimates from 1973 survey.

Source: Özbay and Shorter (1970); Özbay (1979).

indicated by noting that use of the "early 1960s" pattern as a fixed standard would give somewhat lower estimates of the total fertility rate.

The point which is in doubt is the extent of deliberate fertility control in the 1930s. Differentials in marital fertility existed at that time between rural and urban, and between eastern and western Turkey. The size of the differentials apparently was substantial (Taeuber, 1958), but the proportionate weight of the lower fertility groups in the total population presumably was small, because the level of national fertility was high at that time. Since natural fertility itself can vary as to

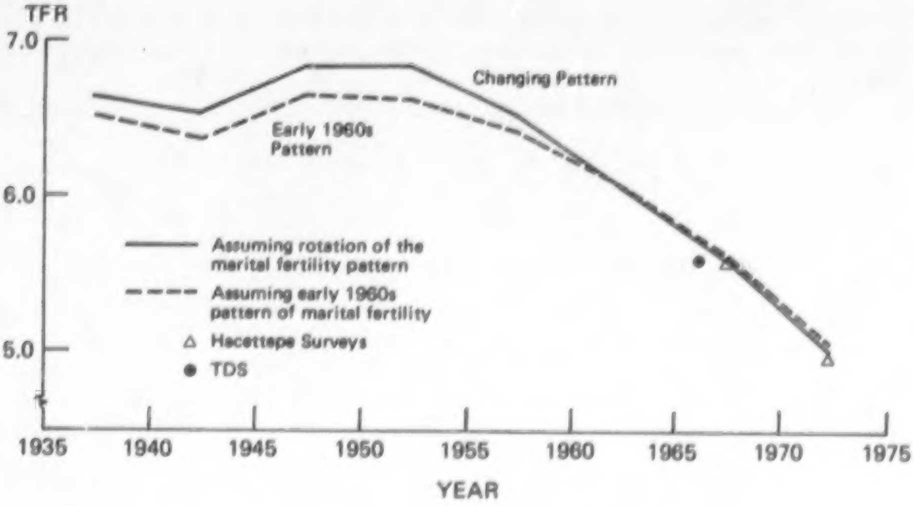


FIGURE 8 Estimates of Total Fertility Rate, 1935-75: Turkey

level, this could have been a contributory factor to the differentials of marital fertility in the 1930s, but the complete story remains obscure.

Other Estimates

The trend of total fertility rates may be checked for the more recent years by examining the results of fertility surveys that include information on both marital fertility and proportions married by age. The Hacettepe national surveys of 1968 and 1973 are of this type. The principal risk with this type of single-round survey data is a problem known as "reference-period error." When women (or other persons on their behalf) are asked to report births during the year preceding a survey, they easily become confused about the period being referred to or simply may not know whether recent births occurred exactly within the last year. When this happens, there is usually an accumulation of error which implies shortening or lengthening of the reference period, rather than offsetting errors.

The count of births in the 1973 survey illustrates how different results may emerge, the most probable cause of the differences being reference-period error. The 1973 survey contained two questions on the number of births in the last year. The first was included on the household questionnaire and was asked of the women, if they were available, but otherwise of an adult respondent, usually the head of household. The second was asked on a questionnaire administered only to the married women themselves. The second questionnaire collected a complete pregnancy history and great care was taken to date events as accurately as possible within the limitations of the respondents' knowledge and understanding. The first procedure yielded a total fertility rate of 4.66 children (Toros, 1978); the second, based on tables from the same survey, a rate of 5.00 children. Presumably the second is more nearly accurate than the first; however reference-period error remains as a distinct possibility.

Total fertility rates for the year preceding each of the Hacettepe surveys, which are subject to reservations about reference-period error, may be used as point-in-time estimates. These rates are also plotted in Figure 8 to be compared with the trend derived from crude birth rates.

Another estimate shown in Figure 8 comes from the Turkish Demographic Survey's dual-record system, which is less subject to reference-period error because of repeated interviewing of the same persons. Reported births, when raised by the standard dual-record adjustment for omissions, give a total fertility rate of 5.62 for 1966-67.

Finally, a preliminary TFR estimate for 1977-78 is given by the first report of the Haceteppe survey of 1978 (Hacettepe Institute of Population Studies, 1980), which was released after the Panel had completed its work. Based on births reported in the pregnancy histories, the estimated TFR is 4.3 children. Although this estimate is not shown in the figure, an extrapolation of the solid curve in that figure would give an estimate for 1977-78 that is very close to the survey estimate. However, no firm judgment can be reached about the level of fertility in 1977-78 because the types of data available so far are inadequate for that purpose.

Since total fertility rates derived from the trend of crude birth rates stand up well when compared with survey-based estimates, both the crude birth rates and derived total fertility rates may be considered as broadly confirmed for the decade from roughly 1965 to 1975.

NATIONAL TRENDS IN MARITAL FERTILITY, 1935-75

It can be assumed that virtually all births in Turkey are legitimate. That being so, all Turkish fertility is fertility within marriage, for which an appropriate measure of trends would be an index of marital fertility. The changing shape (age distribution) of marital fertility has been discussed in the preceding section. In addition, it is useful to measure the level of marital fertility and its trend.

Index of Marital Fertility

A suitable index of marital fertility is total marital fertility (TMF), defined as $\sum \underline{g}(\underline{a})$, where $\underline{g}(\underline{a})$ is the age-specific marital fertility rate for the ages, $\underline{a}$, of reproduction. TMF measures the average number of births women would have if they lived in a continuously married state from age 15 through 49. Since few women are married so early for an uninterrupted 35 years, total marital fertility is not actually achieved by the average woman. Nevertheless, it shows the level of fertility taking place within marriage. The index changes as the interplay of natural controls (e.g., breastfeeding) and voluntary controls (e.g., contraception) affect marital fertility.

The index is estimated below, but first it is necessary to estimate an index for marriage, which provides a convenient intermediate factor for the computation and is of interest in itself.

Index of Proportions Married

The difference between total marital fertility (TMF) and the total fertility rate (TFR), which is necessarily lower, is due to women spending part of their reproductive years unmarried. The greater the extent of non-marriage during these years, weighted by potential childbearing, the greater the difference between TMF and TFR. An index of proportions married, C_m, captures this factor (Bongaarts, 1978):

$$C_m = \frac{\sum m(a)g(a)}{\sum g(a)}$$

where m(a) is the schedule of proportions married by age a and the other terms are as above. When all women are married at all ages from 15 through 49, the value of the index is one; when none are married, it is zero. Since the schedule for marital fertility, g(a), is simply a weighting device, standard schedules of marital fertility are suitable. A changing age-pattern of marital fertility based on the rotation assumption (see above) was used to calculate the index, together with the information on proportions married given in Table 5.

Relationships Among the Indexes

So long as there are no births outside marriage, the marriage index is a direct link between TMF and TFR, that is: TFR = C_m (TMF). This relationship allows TMF to be estimated when the other two variables are already known, as in the present instance. The results for all three indexes are presented in Table 7. (See also Figure 12).

Factoring the total fertility rate into its two components, marriage and marital fertility, shows how the decline of total fertility came about. Although exact dating of turning points is impossible with the data at hand, the decline in marital fertility appears to have begun around 1950. Proportions married, however, were rising at that time and continued to rise for perhaps a half or full decade. By around 1960, though, the marriage index also began to decline. Because of later

TABLE 7 National Fertility Indexes, 1935-75: Turkey

Period	Total Fertility Rate (TFR)	Index of Marriage (C_m)	Total Marital Fertility (TMF)
1935-40	6.66	.747	8.92
1940-45	6.55	.753	8.70
1945-50	6.85	.766	8.94
1950-55	6.85	.784	8.74
1955-60	6.54	.793	8.25
1960-65	6.10	.782	7.81
1965-70	5.63	.764	7.37
1970-75	5.05	.740	6.82

timing in the marriage turnabout, the decline of total fertility did not get securely under way until about the mid-1950s.

The table below shows the approximate relative contribution of the two factors to the decline of total fertility.

	TFR	C_m	TMF
1950-55	6.85	.784	8.74
1970-75	5.05	.740	6.82
Annual percentage rate of decline	1.52	0.29	1.24
Relative contribution to the decline in TFR	100%	19%	81%

The stronger contribution of changes in marital fertility, accounting for 81 percent of the decline in total fertility, suggests that voluntary control of fertility within marriage has been more important than the reduction in the prevalence of a married state during the reproductive ages. Nevertheless, the marital status of the female population remains an important factor. It accounted for 19 percent of the decline up to 1970-75, and the currently high marriage proportions make it a potential factor for future change.

Marriage Trends

Sustained fertility decline is typically the outcome of changes in demographic behavior that occur earlier in time. This is true of the impact of marital status on fertility in Turkey. Whenever the age of first marriage changes, some years pass before the change in number of newly married women moves through the initial ages of childbearing and has its full impact. In Turkey, the time lag is not much more than the period to the next census (five years), because almost all Turkish women have married by their mid-20s in any event.

The mean age of first marriage for different cohorts, shown in Table 8, was calculated by the Hajnal method

TABLE 8 National Number of Women Ever Married, per 1,000 Women by Cohorts, and Mean Age of First Marriage (SMAM), 1930-35 to 1970-75: Turkey

Age Group	Cohorts Identified by Period When Age 15 Attained								
	1930-1935	1935-1940	1940-1945	1945-1950	1950-1955	1955-1960	1960-1965	1965-1970	1970-1975
15-19	237	[a]	265	318	403	339	277	251	216
20-24	[a]	812	836	862	851	838	804	738	--
25-29	941	945[b]	933	958	956	946	932	--	--
30-34	969[b]	951	976	978	976	966	--	--	--
35-39	973	980	982	984	979	--	--	--	--
40-44	985	984	985	979	--	--	--	--	--
45-49	984	985	983	--	--	--	--	--	--
SMAM	20.0	19.9	19.6	19.1	18.8	19.2	19.8	20.2	20.8[c]

Note: In instances in which data were not available for the cohort's entire history, SMAM was calculated by fitting a standard marriage schedule (Coale, 1971) to the available data.

[a] The 1940 census does not provide information on marital status.

[b] Data for a ten-year age group in the 1950 census were split.

[c] The SMAM for the 1970-75 cohort is a preliminary estimate based on the assumption that the past association between SMAM and the proportion of ever married among women aged 15-19 (as expressed by a fitted curve) continues to prevail.

(see Hajnal, 1953, and singulate mean age of marriage in glossary). Cohorts of women are identified by the periods during which they pass the age of 15. Thus, women aged 15-19 in a census all entered marriageable ages during the preceding five-year period.

The use of five-year age groups and the effect of age misreporting in the census (Yener, 1969) biases the estimates of SMAM upward; however, the error would be at most half a year. Because the error is a systematic one due to stable features of the underlying data, these SMAM estimates can be used as a satisfactory indicator of trends. Data from surveys of married women that ask the age at which the women were first married were not used to estimate average age of first marriage. Recall error is present in data of this type, and there is a selection factor (only women already married are interviewed) that seriously biases the estimate downward. Neither of these forms of error exists in the census-type data to which the Hajnal method was applied.

Figure 9 illustrates the lagged effect on proportions married of new cohorts coming along with higher or lower mean ages of first marriage. The inverse relationship holds for both downward and upward movements of the SMAM. It can safely be predicted, therefore, that the continuing increase in the SMAM for the cohort entering marriageable ages in 1970-75 will cause a further decrease in the index of marriage in 1975-80.

One consistent upward pressure on the marriage index during the entire period from 1935 to 1975 was a decline in widowhood. This force is now largely spent, because widowhood within the main reproductive years has fallen to near negligible levels. In 1935, 39 percent of women at the end of the reproductive period (age 50) had been widowed without remarrying; in 1975, this proportion was down to 12 percent. The main cause of this change has been the rising expectation of life of husbands.

A good way to measure the effect of changing widowhood on the index of proportions married, C_m, is to calculate an analagous index for widowhood, C_w by substituting values of $w(a)$ for $m(a)$ in the definition of C_m, where w is the proportion widowed. These calculations yield the following results:

Index	1935-40	1955-60	1970-75
C_m (proportions married)	.747	.793	.740
C_w (proportions widowed)	.047	.020	.012

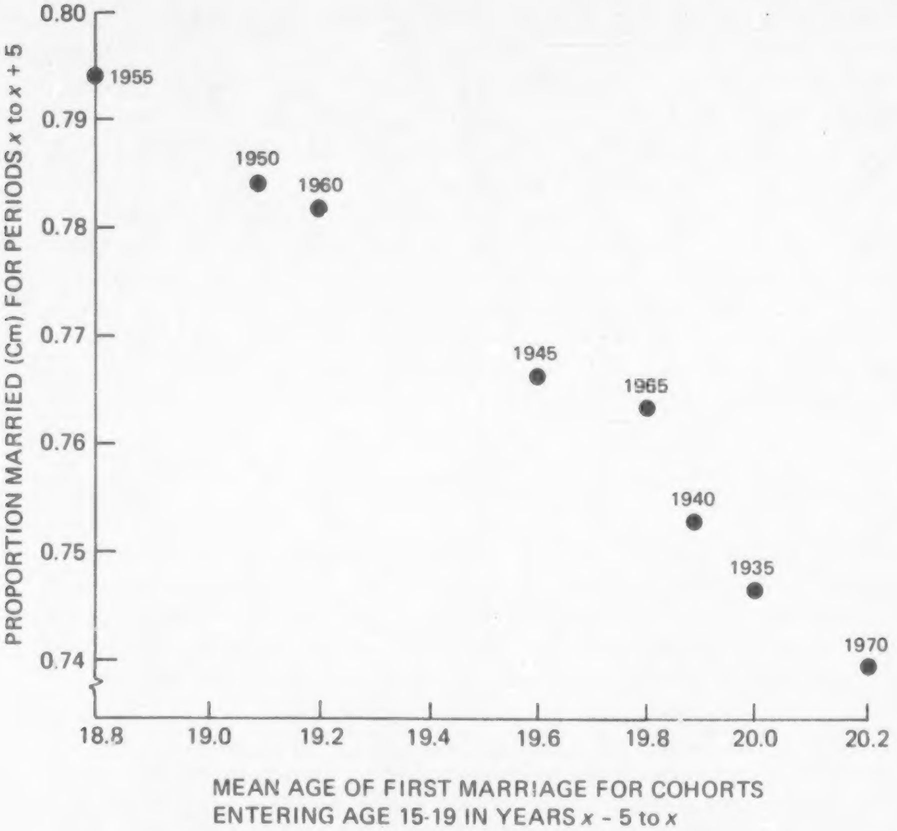


FIGURE 9 National Mean Age of First Marriage for Cohorts and Current Index of Proportion Married (C_m), 1935-75: Turkey

Note: For each point, the date x is shown. As an example, the point labeled 1955 plots the value of C_m for 1955-60 against the value of SMAM for the cohort entering marriageable ages 1950-1955.

When the index of proportions married was rising from 1935-40 to 1955-60, the main factor responsible was declining widowhood (which accounts for more than half the change), not a declining age of marriage although marriage was occuring earlier. During this period, irregularities of the age and sex structure were working themselves out, and economic conditions in agriculture improved, leading to earlier marriage. Nevertheless, the most important indirect influence on fertility was the reduction of death rates, because it reduced widowhood among women.

FERTILITY BY DIVISIONS OF THE POPULATION, 1945-68

The history of the fertility plateau and the subsequent decline of fertility in Turkey can be enriched by examining trends in subdivisions of the population. Data for this purpose are not as abundant nor as tractable by robust methods of estimation as the national data, so the same degree of precision cannot be claimed for divisional as for national estimates. Nevertheless, the broad outlines that can be documented are sufficiently unusual when compared with the demographic history of other countries to constitute a valuable addition to information about Turkey.

Divisions of the Population

The classic method of defining subpopulations in censuses is by the administrative divisions of the country. While subdivisions along socioeconomic dimensions would probably be more illuminating for the analysis of fertility differentials and changes, census and survey reports typically do not exploit this potential. However, a modest socioeconomic dimension can be introduced by making an urban-rural distinction. The number of divisions that can be defined is limited by the sample size of the surveys that are used at certain points in the estimation process. The six divisions finally demarcated, three urban and three rural, are shown in Figure 10.

The cities of Istanbul and Izmir were combined in a single division in order to create a sample size large enough for estimating the mortality parameters that are used for indirect estimation. Studies of fertility at the level of individual cities, conducted in 1966-67 by the Turkish Demographic Surveys, show that Ankara had substantially higher fertility than either Istanbul or Izmir, which were similar to each other (Turkey, School of Public Health, 1970). Because the robustness of divisional estimates is increased by aggregation, considerable use is made below of a three-division urban-rural grouping in which the rank order is (1) Istanbul and Izmir cities, (2) other urban (populations of 10,000 and over), and (3) rural (populations under 10,000).

For the divisional estimates of fertility, census information at a provincial rural-urban level was

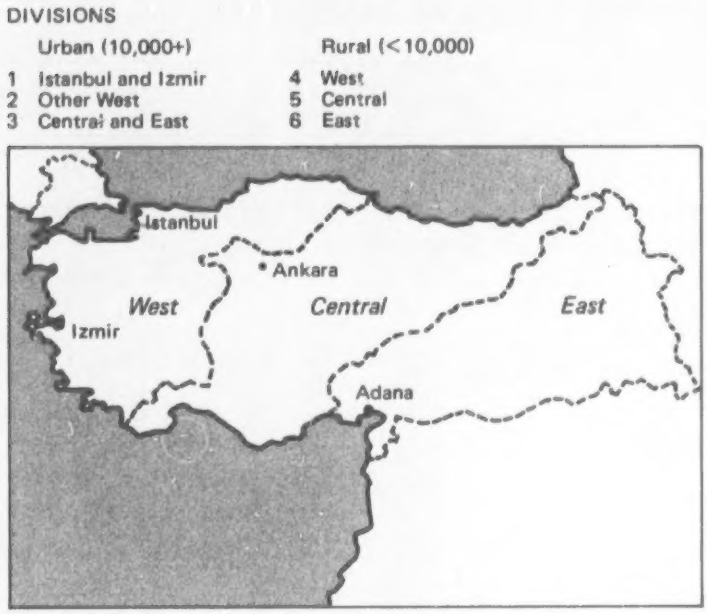

DIVISIONS
Urban (10,000+)
Rural (<10,000)
1 Istanbul and Izmir
2 Other West
3 Central and East
4 West
5 Central
6 East
Istanbul
Ankara
West
Central
East
Izmir
Adana

FIGURE 10 Urban-Rural and Regional Divisions of Turkey

aggregated into six divisions (combined for some purposes into three divisions) for the six censuses from 1945 to 1970. Table 9 presents a summary of population size and growth by divisions, which is based on these aggregations. The results of the aggregations are given in full detail in Appendix E (Table E-1). The other key element in the procedure for indirect estimation of fertility is information on infant and early childhood mortality by divisions, which is drawn from estimates described in Chapter 3.

Estimating Crude Birth Rates

The crude birth rate has been estimated using a method that depends upon an age distribution from a single census and child mortality for the period immediately preceding the census (U.N., 1967). The first step in the method is to choose a model life table on the basis of the child mortality information. Tabulated stable populations based on the selected life table are then used to look up the birth rate associated with a population proportion under age 10. This is an efficient

TABLE 9 Population Size and Growth by Six Divisions, 1945-70: Turkey

Population Unit	Census 1945	1950	1955	1960	1965	1970
Part A. Population Size (in millions)						
National	18.8	20.9	24.1	27.8	31.4	35.6
Urban						
Istanbul-Izmir	1.06	1.21	1.57	1.83	2.15	2.77
Other West	.93	1.08	1.45	2.16	2.78	3.74
Central and East	1.45	1.61	2.37	3.28	4.41	6.21
Subtotal	3.44	3.90	5.39	7.27	9.34	12.72
Rural						
West	6.22	6.68	7.24	7.76	8.17	8.28
Central	5.47	6.12	6.67	7.39	7.99	8.26
East	3.66	4.25	4.77	5.34	5.89	6.33
Subtotal	15.35	17.05	18.68	20.49	22.05	22.87
Part B. Percentage of Total Population						
Urban						
Istanbul-Izmir	5.6	5.8	6.5	6.6	6.9	7.8
Other West	5.0	5.1	6.0	7.8	8.9	10.5
Central and East	7.7	7.7	9.9	11.8	14.0	17.4
Subtotal	18.3	18.6	22.4	26.2	29.8	35.7
Rural						
West	33.1	31.9	30.1	28.0	26.0	23.3
Central	29.1	29.2	27.7	26.6	25.5	23.2
East	19.5	20.3	19.8	19.2	18.8	17.8
Subtotal	81.7	81.4	77.6	73.8	70.2	64.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

and only trivially biased method for making reverse projections over a short period of time. Turkish mortality has a strongly deviant age pattern (see Chapter 3) which imparts a slight downward bias to the birth rate estimated by this method.

The proportion of the population under age 10 is used, rather than some other index of the age distribution, because age misreporting under age 10 causes over- and understatements at different ages, which are largely offsetting. Using age 5 as the upper limit would give proportions that were too low. Data on porportions under age 10 are taken from Appendix E, Table E-1. Infant mortality estimates for approximately three years before each census are the estimates made below in the chapter on mortality (see Table 20 for rural and 23 for urban). A small amount of extrapolation of the mortality series before 1945 and after 1967 was necessary to provide appropriately dated mortality assumptions for the earliest and latest censuses (1945 and 1970, respectively).

The crude birth rate was then estimated for periods centered at five-year intervals, approximately 1943, 1948, . . . 1968. To emphasize that these are estimates of the birth rate for a period of time before the census date, which cannot be dated precisely, and to avoid having to make any assumptions about the special circumstances of the 1940-45 World War period, the initial series of estimates of the birth rate were treated as preliminary. Pairs of estimates for successive periods were then averaged. For example, the estimates for about 1940-45 (centered on 1943) and for 1945-50 (centered on 1948) were averaged to obtain an estimate corresponding approximately with the census of 1945, which is exact year 1945.8. Thus, a series of crude birth rates by divisions was produced for the census years 1945, 1950, . . . 1965, followed by an estimate for 1968 that is dependent on the single census of 1970.

Table 10 presents, as an example, the computations for Istanbul and Izmir. A summary of the results for all divisions is shown in Table 11, together with a population-weighted mean for the nation. The national means are not expected to agree exactly with crude birth rates estimated earlier by multiple reverse projection (Table 2), because a different procedure is involved.

A possible source of error in making the divisional estimates of births is the effect of migration on the divisional age structures. The critical index of age structure used for indirect estimation is the proportion under age 10, denoted as C(10). If the proportions migrating above and below age 10 are similar, the amount of error is limited. Although migration is age-selective in favor of young adults in the working ages, it also includes children under age 10 as part of family migration, which tends to limit changes in the index C(10) due to migration. A study of the net balance of urbanward migration in Turkey shows that 30 percent of the total population of migrants from 1955 to 1965 was under age 10 (Tekce, 1974). This is somewhat below the C(10) value for the rural population (32 percent), and above that for the urban population (24 percent).

TABLE 10 Estimation of Crude Birth Rate for Istanbul and Izmir, 1945-68: Turkey

Census Information[a]			Infant Mortality		Preliminary CBR	Final CBR	
Exact Date of Census[b]	C(10)		Exact Date of Estimate[b]	$_{1}q_{0}$ (Both Sexes)		Date of Estimate	(Per 1000)
	Female	Male			(Per 1000)		
1945.8	.1464	.1363	1943.0[c]	.166	17.42	1945	18.7
1950.8	.1657	.1576	1948.0	.152	19.92	1950	21.0
1955.8	.1896	.1698	1953.0	.138	22.14	1955	22.5
1960.8	.1977	.1772	1958.0	.123	22.79	1960	22.9
1965.8	.2005	.1837	1963.0	.110	23.06	1965	22.8
1970.8	.2014	.1824	1968.0[c]	.096	22.62	1968	22.6[d]

[a] From Appendix E, Table E-1.

[b] Decimals indicate the exact date of the census or estimate to the nearest one-tenth year. For example, the 1965 and 1970 censuses in Turkey were conducted on 24 October and 25 October, respectively. The dates 1943.0, 1948.0, etc. refer to the beginning of each indicated year.

[c] Extrapolated from nearest date.

[d] For all dates except 1968, estimates are based on information from two censuses. The estimate for 1968 depends on the census of 1970 only.

Migration has little effect on estimates of the crude birth rate for the rural population, because the amount of migration is small relative to the total base population. However, migration does produce some upward bias in estimates of the urban crude birth rate.

Another possible source of error is variations in age misreporting from census to census which could upset the choice of C(10) as a good measure of population structure. Because of these sources of error, one must be wary in drawing conclusions beyond noting the main differentials and trends.

TABLE 11 Estimated Crude Birth Rates by Six Divisions, 1945-68: (per thousand population): Turkey

Approximate Date of Estimate	Urban			Rural			National[a]
	Istanbul and Izmir	Other West	Central and East	West	Central	East	
1945	18.7	26.0	32.8	39.2	56.5	56.0	45.2
1950	21.0	28.5	35.0	40.6	55.5	57.4	46.2
1955	22.5	29.8	36.8	42.2	55.0	59.0	46.7
1960	22.9	29.7	37.5	41.0	51.4	58.2	44.6
1965	22.8	28.9	37.0	38.5	48.9	56.2	42.3
1968	22.6	28.7	36.4	37.1	47.0	55.3	40.7

[a] Population-weighted mean of the separate divisional estimates.

The Turkish Demographic Survey provides some independent estimates of urban and rural birth rates for 1966-67. When the TDS estimates for Istanbul and Izmir in that year are combined, they give an estimated CBR of 24.3 births per thousand (Turkey, School of Public Health, 1970). This is slightly higher than the estimate of 22.7 per thousand for approximately the same date, interpolated from Table 11. The TDS estimate of the rural birth rate is 43.9 per thousand for a slightly different definition of rural, lower than the combined rural estimate of 46.5 interpolated for the same date from Table 11. Thus, the spread of birth rates between the divisions of the country is somewhat larger when estimated by the procedures used here than by those of the Turkish Demographic Survey. These differences, while not very great, underline the importance of accepting only the broad outlines of results rather than their specific details, especially where errors of this magnitude could upset conclusions.

Various Fertility and Marriage Indexes

Once crude birth rates are known by divisions, the same procedures used to derive the various national fertility and marriage indexes may be applied to divisional data. The principal additional data requirements for these calculations are proportions of women married by age and standard distributions for marital fertility, both shown in Table 12. The marital fertility schedules in Figure 11 show the characteristic differences between a rural population using relatively little fertility control and urban populations exercising greater control.

The additional measures of fertility and marriage shown in Figure 12 and Table 13 reveal that urban-rural differentials have persisted in Turkey for some time, probably going further back in history than can be measured with available data. There appears to have been some narrowing over the period covered here, due to both a slight rise in urban fertility and a decline in rural fertility. This rise in urban fertility since 1945 is a genuine finding; it is not a statistical artifact connected with the definitions of rural and urban. During this period the urban population's age of first marriage and the prevalence of widowhood fell. In addition, strong streams of migration to the cities of more people with rural origins probably tended to raise the average level of urban fertility (see Table 14).

TABLE 12 Proportions Married Females by Divisions of the Population, 1945-68 and Standard Marital Fertility Schedule: Turkey

Age Group	Proportions Married						Marital Fertility[c] (percent)
	1940[a]	1950[a]	1955	1960	1965	1968[b]	
Istanbul and Izmir							
15-19	.143	.186	.232	.201	.192	.201	17.1
20-24	.503	.570	.647	.661	.653	.660	30.5
25-29	.680	.740	.785	.819	.843	.840	25.4
30-34	.778	.794	.830	.857	.881	.892	15.8
35-39	.780	.803	.814	.850	.869	.879	8.4
40-44	.733	.779	.797	.816	.834	.848	2.2
45-49	.662	.642	.730	.771	.775	.780	.5
Other Urban							
15-19	.199	.241	.305	.276	.238	.232	21.6
20-24	.728	.757	.781	.791	.776	.763	29.3
25-29	.884	.886	.887	.910	.916	.913	22.1
30-34	.913	.914	.915	.928	.939	.940	12.8
35-39	.886	.895	.903	.918	.926	.932	9.6
40-44	.820	.840	.861	.876	.891	.897	3.9
45-49	.738	.769	.800	.829	.837	.846	.7
Rural							
15-19	.277	.336	.425	.360	.294	.279	19.6
20-24	.816	.849	.876	.867	.864	.848	23.6
25-29	.926	.928	.929	.959	.958	.953	20.4
30-34	.920	.921	.922	.959	.966	.964	17.7
35-39	.906	.916	.924	.947	.953	.954	13.2
40-44	.839	.860	.881	.904	.917	.922	4.6
45-49	.773	.805	.838	[illegible]73	.879	.886	1.0

[a] With the exception of Istanbul and Izmir, for which separate census data are available, estimates for 1945 and 1950 are based on the assumption that proportions married changed in each age group in each division from 1945 to 1955 in the same proportions as they changed in the national population.

[b] Based on interpolation between 1965 and 1970.

[c] From 1963 National Population Survey.

A by-product of the fertility estimates by divisions of the population is information on the number of annual births. In 1945, 90 percent of births in Turkey were rural; by 1968, the proportion was 75 percent. The quantity of rural births is no longer increasing and will almost certainly decline, while that of urban births is on the increase. Further increases in urban births are firmly indicated by the underlying demographic structure and trends.

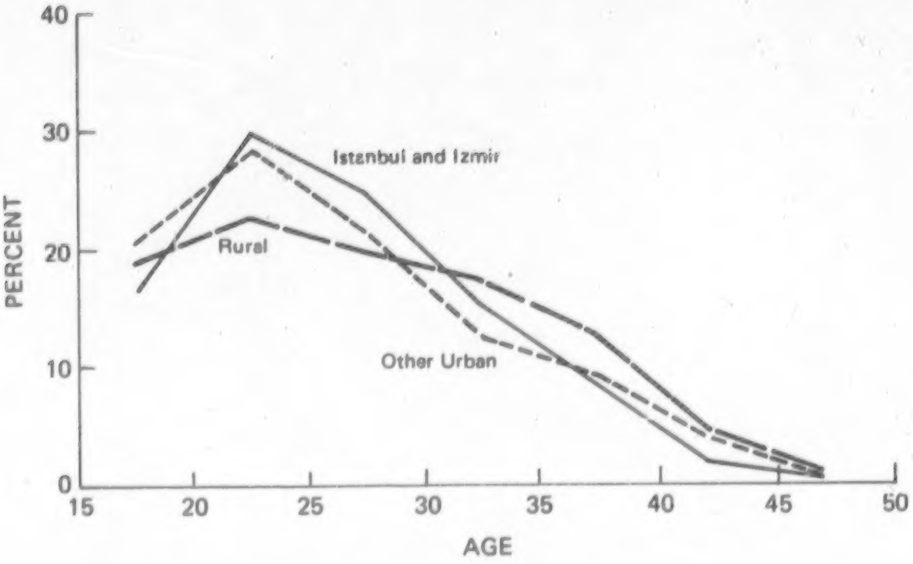


FIGURE 11 Distribution of Marital Fertility by Age, from 1963 National Population Survey: Turkey

Fertility by Province

A striking characteristic of social and economic data for Turkey is the large size of the differentials by province. There are 67 administrative provinces, and a great deal of information is compiled on this basis. The spatial distribution of characteristics blurs the possibly more important rural-urban differences but is nevertheless valuable when used in conjunction with other data.

By utilizing special tabulations of the 1965 census, it is possible to estimate fertility by province for a reference date around 1960. Information on place of birth for the population under age 10 was used to assemble the data by province of birth, thus controlling for the effect of migration on indirect estimates of births. The crude birth rate can then be estimated by province according to the following equation:

$$\text{CBR} = \frac{\text{Yearly Births}}{\text{Mid-period Population}} = \frac{P(0\text{-}9)/{}_{10}L_0}{P(\text{Tot})}$$

where P(0-9) refers to the population under age 10 born in the province and surviving at the time of the 1965

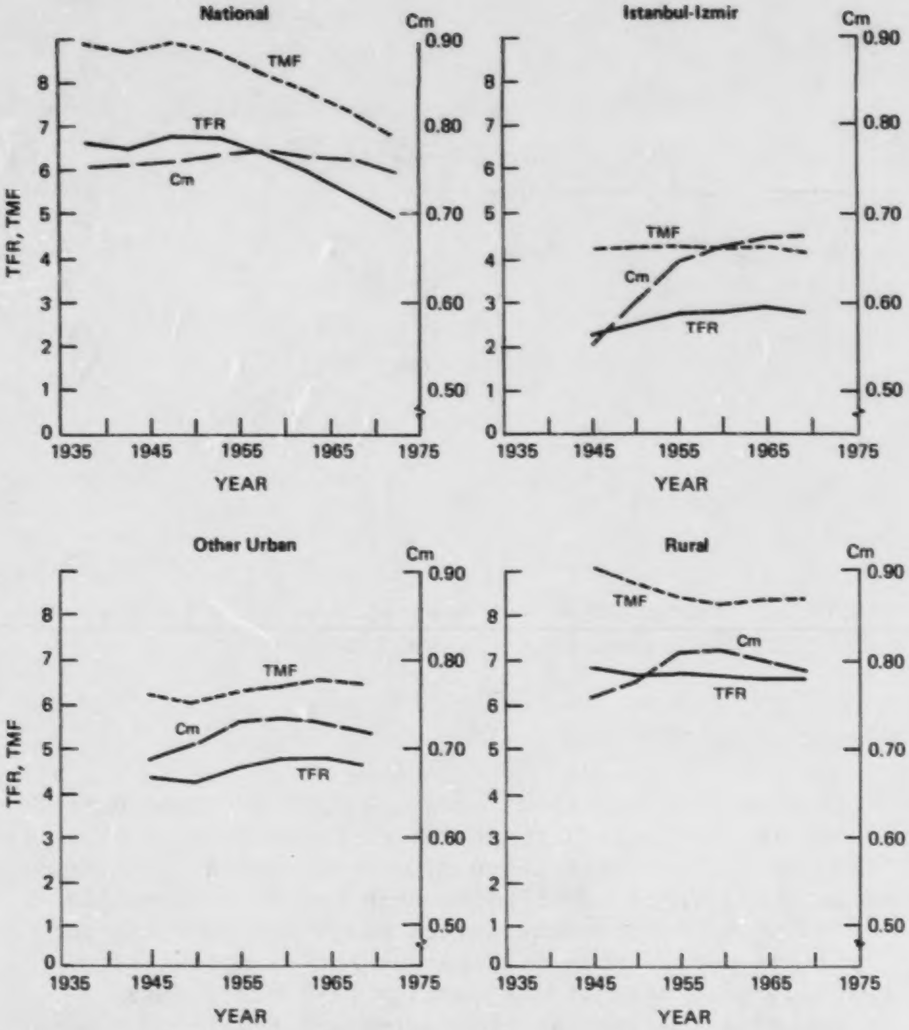


FIGURE 12 Fertility Measures and Marriage Indexes, 1935-75: Turkey

census enumeration. This population of survivors is divided by the person-years lived in a suitable life-table between birth and age 10 using a radix of 1.0. The resulting numerator is an estimate of average annual births for the province over the preceding 10 years. The denominator is the total population enumerated in the province five years earlier, in 1960.

Total fertility rates can also be calculated by choosing standard age-specific fertility distributions

TABLE 13 Fertility and Marriage Indexes by Divisions, 1945-68: Turkey

	Fertility and Mortality Indexes					First Marriage Indexes	
Date	CBR	Births (000s)	TFR	C_m	TMF	Proportion Single (15-19)	SMAM[a]
Istanbul-Izmir							
1945	18.7	20	2.41	.558	4.32	.851	22.4
1950	21.0	25	2.65	.607	4.37	.808	21.5
1955	22.5	35	2.91	.657	4.43	.761	20.8
1960	22.9	42	2.96	.673	4.40	.792	21.1
1965	22.8	49	3.04	.681	4.46	.804	21.0
1968	22.6	55	2.99	.686	4.36	.785	21.1
Other Urban							
1945	30.1	72	4.36	.691	6.31	.796	20.6
1950	32.4	87	4.31	.711	6.06	.754	20.1
1955	34.2	131	4.60	.734	6.27	.690	19.6
1960	34.4	187	4.72	.759	6.39	.719	19.9
1965	33.9	243	4.78	.731	6.54	.759	20.2
1968	33.5	281	4.70	.726	6.47	.772	20.5
Rural							
1945	49.4	758	6.99	.765	9.14	.718	19.5
1950	50.1	855	6.84	.787	8.69	.659	18.9
1955	51.3	957	6.86	.814	8.43	.568	18.5
1960	49.2	1009	6.82	.816	8.36	.635	18.9
1965	47.0	1036	6.78	.805	8.42	.703	19.5
1968	45.9	1028	6.73	.797	8.44	.736	19.8

[a] SMAM refers to the cohort passing age 15 during the five years preceding the date shown. Estimates of SMAM have an upward bias of up to one-half year (see text for further discussion).

based on TDS data and following the procedures described above for estimating divisional and national total fertility. The results are shown in Figure 13.

For the production of these estimates mortality assumptions in terms of $_{10}L_0$ from the Turkish Demographic Survey for 1966-67 were accepted. They refer to five regions and separately to Istanbul, Izmir, and Ankara cities. They were scaled so that the computed national birth rate would equal an estimate of the 1960 national birth rate of 45 births per thousand population. These mortality assumptions by TDS regions do not capture the finer detail of province-by-province differences in child mortality. The sensitivity of estimates of births to error in the mortality assumptions can be judged by making the extreme assumption of western Turkish mortality for the east of the country. In that event, the estimate of the total fertility rate for Hakkari province in the southeast corner of Turkey would be reduced from 10.6 to 9.5 children per woman indicating rather limited sensitivity.

TABLE 14 Components of Urban Population Growth,
1945-70: Turkey

	(Thousands)					
Component	1945-1950	1950-1955	1955-1960	1960-1965	1965-1970	Total (millions)
Total Increase	459	1,491	1,882	2,072	3,381	9.3
Births	510	695	988	1,303	1,680	5.2
Deaths	-329	-374	-454	-527	-600	-2.3
Natural increase	181	321	534	776	1,080	2.9
Reclassification	50	210	330	390	650	1.6
Migration	228	960	1,018	906	1,651	4.8
International	14	56	54	-121	-201	-0.2
Internal	214	904	964	1,027	1,852	5.0
Annual Percentage Growth Rate	2.5	6.5	6.0	5.0	6.2	

Note: This table is based on Tekce's (1974) chapter on the components of urban population growth from 1935 to 1970. The most problematic estimates are the allocations of international migration to the urban or rural populations. For 1945-60, Tekce divided international migration into urban and rural destinations on the basis of information about resettlement locations in Turkey for immigrant Turks; for 1960-75, she used reports of the worker recruitment services to divide into urban and rural origins.

Tekce's estimates of the components of urban growth are revised here by using birth rates from the present report. Her death rate is the TDS estimate for 1966-67 (11 per thousand) extended backward in time by linear interpolation to an assumed value of 18 per thousand during 1945-50. The assumed decline in the death rate was less steep in urban than rural Turkey, consistent with the estimates in Figure 4. The net balance of internal rural-to-urban migration is an unknown in the overall balance equation for each period and is therefore estimated as a residual. Errors in other components affect the internal migration estimate.

Variations in age misreporting, child mortality within regions of the TDS, and census coverage between 1960 and 1965 are all possible sources of error in provincial estimates. Nevertheless, the broad tendencies of the results by province are probably valid and are a valuable complement to other social data at the provincial level, such as infant mortality (see Table 24).

Fertility by Social Class

Although a classification of the whole population by socioeconomic groups is not feasible, some information is available about differences along this dimension. Using

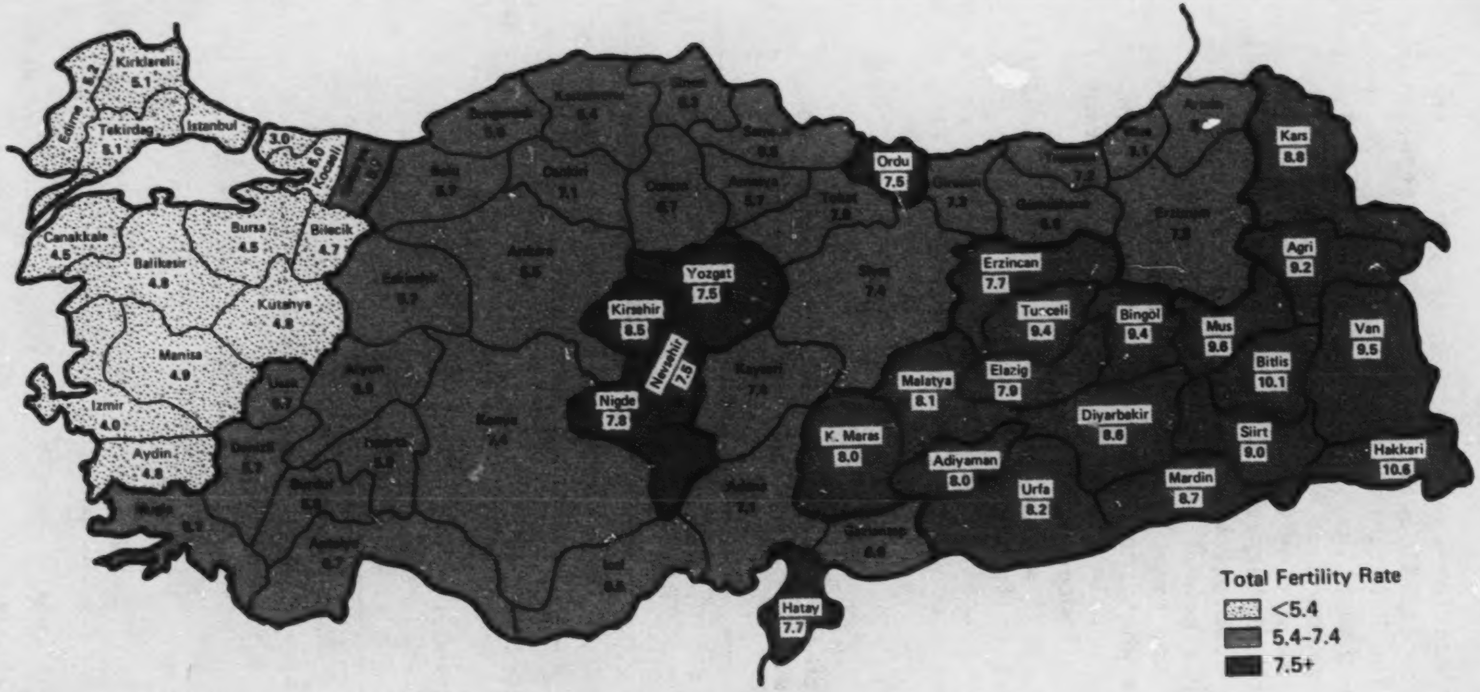

Kirklareli 5.1
Edirne 5.2
Tekirdag 5.1
Istanbul
3.6
Kocaeli 5.0
Canakkale 4.5
Bursa 4.5
Bilecik 4.7
Balikesir 4.8
Kütahya 4.8
Manisa 4.9
Izmir 4.0
Aydin 4.8
Yozgat 7.5
Kirsehir 8.5
Nevsehir 7.5
Nigde 7.8
Ordu 7.5
Kars 8.8
Agri 9.2
Erzincan 7.7
Tunceli 9.4
Bingöl 9.4
Mus 9.6
Van 9.6
Bitlis 10.1
Malatya 8.1
Elazig 7.9
Diyarbakir 8.6
K. Maras 8.0
Siirt 9.0
Hakkari 10.6
Adiyaman 8.0
Urfa 8.2
Mardin 8.7
Hatay 7.7
Total Fertility Rate
▨ <5.4
▩ 5.4–7.4
■ 7.5+

FIGURE 13 Total Fertility Rates by Province, 1960: Turkey

mother's education as an approximate index of social class, Timur (1974) estimated fertility differentials from the 1968 Hacettepe Survey (Table 15). These data suggest, although they do not prove conclusively, that relative expansion of the size of the lower socioeconomic groups in the cities does tend to raise fertility overall. Such a simple interpretation of the increase in urban fertility, however, would miss complex factors that lie outside the scope of the present work. It remains to be explained, for example, how urban fertility could cease to increase when the proportions of rural-origin, lower-class population in the cities has apparently continued to increase.

For the rural areas, Timur's data show very little differential in fertility by social class when class is measured by education of mothers. While this rules out a simple numeric connection between rural fertility trends

TABLE 15 Births by Education of Mother, Standardized by Duration of Marriage, from the 1968 Hacettepe Survey: Turkey

Educational Attainment	Three Largest Cities	Other Cities	Town	Village
Part A. Number of Children Ever Born per Married Women Under Age 45				
Illiterate	4.1	3.8	4.3	4.3
Some schooling	2.5	3.1	3.1	3.8
Primary (5 years)	2.6	2.7	2.6	3.2
Secondary (8 years)	1.9	2.9	a	a
Total	2.7	3.2	3.8	4.2
Part B. Proportionate Distribution (percentages)				
Illiterate	20	51	61	83
Some schooling	23	18	15	8
Primary (5 years)	33	26	21	9
Secondary (8 years)	24	5	a	a
Total	100	100	100	100

[a]Too few cases to make an estimate.

Source: Timur (1974).

and rural class structure at different dates, investigation of fertility differentials and trends by different rural social groups may nevertheless be a profitable line of inquiry (Özbay, 1978). This subject, however, lies, beyond the scope of the present work.

3 Mortality

NATIONAL INFANT AND EARLY CHILDHOOD MORTALITY, 1945-75

When trends of infant and early childhood mortality cannot be estimated accurately from vital registration data, which is the situation in Turkey, a common approach is indirect estimation. Numbers of births in the past and the survival status of those children logically imply measures of past infant and early childhood mortality levels. An indirect estimation procedure is developed to handle the Turkish data and used to estimate past trends. The results are then checked for segments of the entire period 1945-75 by comparison with other types of estimates. Life table information on the age pattern of mortality below age 5 is also presented.

Strategy of Estimation

Infant and early childhood mortality are estimated in Turkey by indirect methods because death registration data are incomplete and defective (see Chapter 1). Miroslav Macura (1975a and b) has developed an indirect method of estimating trends that uses the birth-survival histories contained in the pregnancy history material of national sample surveys. This method, described in detail in Appendix B, was applied to the birth-survival histories collected by the 1968 Hacettepe Survey, which is the only national survey that provides tabulations of the type required.

The trend revealed by the birth-survival history method was then checked at various dates by a second method of indirect estimation originally developed by William Brass (1968). The Brass method, as modified by

James Trussell (1975), uses information from a survey or census about the proportions of children born alive who have died up to the time of the survey or census. The information on births and deaths is cross-classified by the ages of the women bearing these children. A second variant of the method cross-classifies the information by the duration of marriage of the women. In both instances, the information about parity and child survival is sufficient to make robust estimates of child mortality that refer to dates several years before the survey or census. For Turkey, two surveys and two censuses contain the type of data needed to make these national point-in-time estimates of child mortality.

Finally, the Turkish Demographic Survey provides an estimate of infant and early childhood mortality for one year, 1966-67, based on direct enumeration of the death events. This estimate is useful as another check point for the national trend of childhood mortality.

Both the Macura and Brass methods of indirect estimation utilize model life tables in their procedures. Although general measures of child mortality, such as those expressed by the proportion dying by age 2 ($_2q_0$), are not highly sensitive to the choice of a standard family of models for the estimation procedure, precision is increased when this choice is based on direct information about the age pattern of childhood mortality. The life-table index most often referenced in the analysis of child mortality is the infant mortality rate, $_1q_0$. Estimation of this particular index, as contrasted with $_2q_0$, is more sensitive to the choice of the model family. It is useful, therefore, to begin by presenting information that justifies the selection of the "East" family of model life tables for the Turkish case. Once satisfied on this point, it is permissible to refer to infant mortality rates as a shorthand description of the general level of infant and early childhood mortality.

Age Pattern of Mortality

Data of adequate quality on deaths by age and sex are available from two dual-record systems in Turkey: the nationwide Turkish Demographic Survey (TDS) of 1966-67 and a 1976 rural health project in Yozgat province. Additional data based on health service records are available from two rural areas: Etimesgut and Cubuk.

The TDS data were used to construct a national life table for 1966-67. This involved a preliminary adjustment of the data to take account of the dual-record omission rate. The TDS data make it possible to estimate omissions separately for births, deaths under age 1, and deaths at higher ages. The life table, shown in Table 16, was constructed from the original TDS data after including this adjustment for omissions.

Another national life table for 1966-67, apparently based on the same data, is available from the State Institute of Statistics (S.I.S.) (Turkey, State Institute of Statistics, 1971). However, since the methods used to adjust the data are not explained, it is not possible to evaluate this table fully. The S.I.S. statistics on infant mortality are the same as those in Table 16, but the mortality rates at higher ages are all lower. Apparently S.I.S. did not use the TDS omission rate to adjust deaths above age 1, with the result that the S.I.S. tables give slightly higher estimates of the expectation of life at birth: 1.0 years higher for males and 1.4 years higher for females.

The age pattern of mortality in Turkey up to age 5, as shown in Table 16, was compared with the four Coale-Demeny (1966) regional families of models (see glossary). This was done by selecting a model level from each family that exactly matches the infant mortality rate of the Turkish table. Figure 14 shows the four model levels that match the Turkish data on proportion of births surviving to age 1 (ℓ_1). Each of the four models predicts a proportion surviving to age 5 (ℓ_5), which is then compared with the Turkish life-table value. As shown, the "East" family gives the best representation of the Turkish childhood age pattern, with "West" being second best.

Further tests were carried out by making the same comparisons by sex, by rural-urban subdivision of the national population, and using the data from the three area studies mentioned above. The results are shown in Table 17. Up to age 5 the national life tables agree most closely with the "East" models. The Yozgat life table is also based on a dual-record system with a sample size similar to that of the TDS (50,000 persons). The Etimesgut and Cubuk life tables are least similar to the "East" models, but even for them the "East" models are the best available representation. The choice of "East" implicitly accepts the "East" pattern of heavy mortality under age 1 as compared with the next higher ages of early childhood. More information concerning the national age pattern of deaths below age 1 and between age 1 and 5 is not available.

Estimates Derived from Birth-Survival Histories

The Macura method for estimating trends in child mortality from birth-survival histories uses information on the date of each birth, survival status of each live-born child at the time of the survey, and the date of death of each child who died before the survey. Implicit in this information is a history of the child survival trends. The mothers alive at the time of the survey are accepted as a representative sample of mothers having children and experiencing child mortality in the past. The procedure is to select model life tables that could account for the levels of survivorship found at the time of the survey in the different birth cohorts of children reported by the mothers. (See Appendix B for a more detailed explanation of the procedure.)

To inspect the consistency of results going back in time from the 1968 survey to 1945, the procedures were applied separately to six subdivisions of the population and then aggregated to obtain the national results shown in Table 18. (The divisional estimates, which are useful for other purposes, are presented later.) When the data are disaggregated to the divisional level, there is sufficient consistency among them to justify accepting the national trend estimates as a valid independent series for childhood mortality. Their origin in a single set of data (the 1968 survey) that gives estimates for different dates all by the same method increases their credibility for trend analysis. Nevertheless, data errors and biases due to unfulfilled assumptions are possibilities, and these are elaborated in Appendix B. It is useful, therefore, to have additional evidence against which to check the results given by this method.

Estimates Derived by the Brass-Trussell Method

The estimation of child mortality from information collected in a census or survey on children ever born (CEB) and children surviving (CS) was first developed by Brass (1968), who calculated a table of multipliers for converting statistics on the proportion dead among CEB

TABLE 16 National Life Table, Based on One Year of Data Centered on February 1967: Turkey

Age(x)	q(x) (1,000)	d(x)	m(x) (1,000)	l(x)	L(x)	P(x)	T(x)	e(x)	Age(x)
Females									
0	143.8	14,380	159.6	100,000	90,077.8	.83914[a]	5,482,588.2	54.826	0
1	56.7	4,853	14.7	85,620	329,493.9	.95746[b]	5,392,510.4	62.982	1
5	10.5	846	2.1	80,767	401,722.1	.99083	5,063,016.4	62.687	5
10	7.9	628	1.6	79,922	398,037.5	.99084	4,661,294.3	58.323	10
15	10.5	830	2.1	79,293	394,391.4	.98798	4,263,256.8	53.766	15
20	13.6	1,066	2.7	78,463	389,650.2	.98538	3,868,865.5	49.318	20
25	15.7	1,212	3.2	77,397	383,953.1	.98356	3,479,215.3	44.953	25
30	17.2	1,312	3.5	76,184	377,642.1	.98099	3,095,262.2	40.629	30
35	20.8	1,560	4.2	74,872	370,462.0	.97712	2,717,620.1	36.297	35
40	25.0	1,830	5.1	73,312	361,987.5	.96874	2,347,158.1	32.016	40
45	37.7	2,697	7.7	71,483	350,671.3	.95707	1,985,170.7	27.771	45
50	48.3	3,325	9.9	68,786	335,617.4	.93670	1,634,499.4	23.762	50
55	79.0	5,173	16.5	65,461	314,372.5	.91034	1,298,882.0	19.842	55
60	101.2	6,102	21.3	60,288	286,185.3	.87462	984,509.5	16.330	60
65	152.3	8,251	33.0	54,186	251,304.4	.79480	698,324.2	12.887	65
70	267.7	12,295	61.8	45,935	198,940.8	.69610	448,019.8	9.753	70
75	353.4	11,889	85.9	33,641	138,481.8	.44402[c]	249,078.9	7.404	75
80	1,000.0	21,752	196.7	21,752	110,597.2	.0	110,597.2	5.084	80

Males									
0	162.0	16,200	183.1	100,000	88,498.0	.81978[a]	5,148,866.6	51.489	0
1	61.3	5,139	16.0	83,800	321,391.0	.95327[b]	5,060,368.6	60.386	1
5	13.1	1,028	2.6	78,661	390,733.8	.98926	4,738,977.5	60.246	5
10	8.4	651	1.7	77,633	386,536.3	.99110	4,348,243.8	56.010	10
15	9.4	726	1.9	76,982	383,095.0	.98669	3,961,707.5	51.463	15
20	17.2	1,313	3.5	76,256	377,997.9	.98329	3,578,612.5	46.929	20
25	16.2	1,213	3.3	74,943	371,682.8	.98253	3,200,614.7	42.707	25
30	18.9	1,384	3.8	73,730	365,190.4	.97944	2,828,931.9	38.369	30
35	22.4	1,619	4.5	72,346	357,681.8	.97330	2,463,741.4	34.055	35
40	31.1	2,200	6.3	70,727	348,133.2	.95819	2,106,059.7	29.777	40
45	52.8	3,621	10.9	68,527	333,579.5	.94472	1,757,926.4	25.653	45
50	57.8	3,754	11.9	64,905	315,140.7	.92600	1,424,346.9	21.945	50
55	91.1	5,574	19.1	61,151	291,821.6	.88191	1,109,206.2	18.139	55
60	147.7	8,211	31.9	55,578	257,360.5	.83849	817,384.6	14.707	60
65	177.7	8,415	39.0	47,367	215,795.3	.76674	560,024.2	11.823	65
70	300.9	11,720	70.8	38,951	165,458.4	.64415	244,228.8	8.837	70
75	434.5	11,831	111.0	27,232	106,580.7	.40381[c]	178,770.4	6.565	75
80	1,000.0	15,400	213.3	15,400	72,189.7	.0	72,189.7	4.688	80

[a] P(Birth).

[b] P(0-4).

[c] T(80)/T(75).

Source: Based on data from the 1966-67 Turkish Demographic Survey.

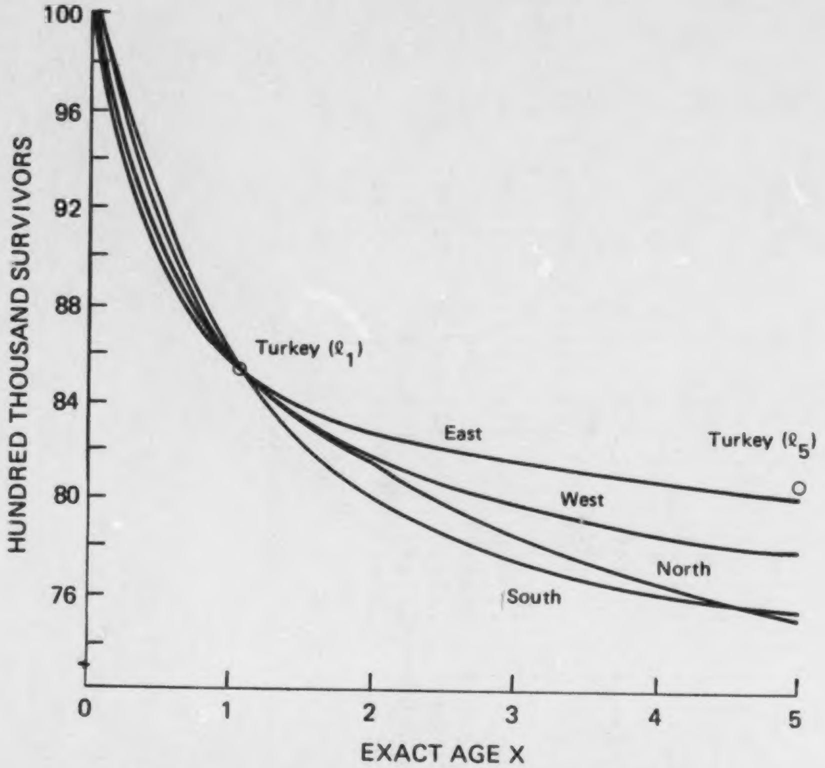


FIGURE 14 Survivors from a Cohort of 100,000 Female Births (ℓ_x). Four Regional Models with same Values for ℓ_1 for Demographic Survey Estimates, 1966-67: Turkey

reported by women in age groups 15-19, 20-24, 25-29, etc., into estimates of the probability of dying before reaching certain exact childhood ages. In conventional terminology D(i) denotes the proportion dead of CEB in successive five-year age groups, with i=1 indicating the age group 15-19, i=2 the age group 20-24, etc. In effect, the Brass multipliers convert D(i) values into estimates of q(x), where q(x) = 1 - l(x), the probability of dying between birth and exact age x.

Brass found that the relationship between corresponding pairs of D(i) and q(x) is primarily influenced by fertility patterns and, in particular, by the age at onset of childbearing. Therefore, the appropriate value of a conversion multiplier depends on the value of P(1)/P(2)--a good indicator of early fertility conditions--where P(i) is the average parity observed among women belonging to age group i. Brass evaluated

TABLE 17 Age Patterns of Early Childhood Mortality in Turkish Life Tables and in the "East" and "West" Families of Model Life Tables: Turkey

Data Source and Population	Observed Proportion Surviving Up to		Proportion Surviving Up to Age 5 Predicted by	
	Age 1	Age 5	"East" Models	"West" Models
TDS (1966-67)				
National females	.856	.808	.801	.777
National males	.838	.787	.788	.764
Rural, both sexes	.832	.773	.773	.749
Urban, both sexes	.887	.858	.852	.835
Yozgat (1976)				
Females	.862	.818	.810	.787
Males	.860	.831	.818	.799
Etimesgut				
Both sexes, 1967-68	.865	.840	.821	.799
Both sexes, 1971-77	.904	.889	.876	.863
Cubuk (1977)				
Both sexes	.868	.844	.825	.804

Note: Data are presented for both sexes combined whenever the number of cases is too small to support separate estimates for each sex.

the appropriate multipliers by modeling fertility schedules as third-degree polynomials. Later, Sullivan (1972) computed another set of multipliers by using regression techniques applied to data obtained from observed fertility schedules. More recently, Trussell (1975) created a third set by the same means but using data generated from the model fertility schedules developed by Coale and Trussell (1974). Of the three sets, the Sullivan and Trussell multipliers are easier to apply. The Trussell multipliers were used in this report.

National data for Brass-type estimates are available from four sources: the 1963 survey of the Ministry of Health, the initial interviews in 1965 and 1966 of the Turkish Demographic Survey, and the censuses of 1970 and 1975. Although appropriate data were collected in the 1968 and 1973 Hacettepe surveys, they are not available. The age model was used for all four sources, because only one (the 1963 survey) contains data suitable for the marriage-duration method of estimation. Since the 1963 survey does not include information on the total number of women but only the number of married women in each age group, data on marital status from the censuses of 1960

TABLE 18 National Infant Mortality Rate, 1945-70: Turkey

Exact Reference Date[a]	Infant Mortality Rate ($_1q_0$) (Both Sexes)	Regrouped by Intercensal Periods	Infant Mortality Rate ($_1q_0$)
1945	274	1945-50	260
1947	270	1950-55	233
1949	255	1955-60	203
1951	245	1960-65	176
1953	235	1965-70	151[b]
1955	224		
1957	212		
1959	199		
1961	189		
1963	178		
1965	169		
1967	156		

[a] Exact reference dates are used for point-in-time dating of estimates. They refer to the exact beginning of the year if no decimal digits are shown.

[b] Extrapolated for second half of period.

Source: The single-date estimates are the result of applying the Macura birth-survival method to the 1968 Hacettepe survey data. The five-year estimates are averages for intercensal periods, from October of each census year to the next, matched to the dates of the multiple reverse projections shown in Table 2.

and 1965 were used to fill this gap in the basic data. Because the age model was used for data from all four sources, comparability of the estimation method is assured.

The Brass method provides an estimate of the child mortality experience of women of successively higher ages. Reliable estimates are usually obtained from women aged 20-24, 25-29, and 30-34. The results are expressed in terms of the infant mortality rate for each age group, using "East" models. When the infant mortality rate is falling, the estimates from women 25-29 should be higher than those from the younger women aged 20-24. The Turkish estimates, presented in Table 19, do not have this pattern; instead, data from women 25-29 yield lower estimates of child mortality than those from women 20-24. This pattern holds true in all four sources. Estimates from women aged 30-34 fall into no regular pattern.

Finding lower estimates of infant mortality associated with women of higher ages is logically acceptable only if the trend of infant mortality is upward. However, the

TABLE 19 Estimates of the National Infant Mortality Rate Based on Reports of Mothers at Different Ages, Four Sources: Turkey (Infant Deaths per Thousand Births)

	Age of Mothers Giving Reports				
Source of Data	20-24	25-29	30-34	Mean for Ages 20-29[a]	Reference Year
1963 survey	211	206	174	208	1960
1965-66 TDS	189	170	164	180	1963
1970 census	154	144	159	149	1967
1975 census	130	128	139	129	1972

[a] Rounding of the numbers that are averaged makes the means appear to contain small errors when they do not.

overall level of the Turkish estimates from each source declines with time. Hence, some form of systematic data error is present. There are various possible explanations.

One theory starts with the observation that women who have had none of their children die have more living children than other women of their same age and fertility. A tendency toward female age exaggeration in precisely the age ranges used for Brass-type estimates is noted elsewhere (see Appendix C on age misreporting). Thus, it is likely that the women with fewer (or no) child deaths, and hence more surviving children will be perceived as being older and will be misreported accordingly. Such selective transfer of women to higher age groups raises the infant mortality rate estimated from the 20-24 age group relative to that estimated from the 25-29 age group.

Another possible explanation is based on the fact that women of low socioeconomic status not only experience higher child mortality than women of higher status but they also marry earlier. Therefore, the women associated with high mortality are a greater proportion of the mothers in the 20-24 age group than in the next higher age group. Most Turkish women have married by their early 20s, so this type of selectivity cannot be very strong in the age group 20-24, but to the extent that it does exist it contributes to the puzzling reversal in the estimates.

Because of these systematic errors in the data, an average of the estimates for the 20-24 and 25-29 age groups is a stronger estimate of the level of childhood mortality than any one of the three available estimates taken alone. Mortality information provided by the women aged 30-34 was not included because the data errors appear to be less systematic from one source to the next.

The Brass-type estimates refer to an average of experience for a number of years preceding the survey date. The date on which this experience centers is calculated and comes to 3.1 or 3.2 years before the survey for the estimates made here (averaged over two age groups of women). For example, the last Turkish census was taken in October 1975; the child mortality estimate based on this census refers to a period centered on mid-1972.

The estimates of childhood mortality (based on the age

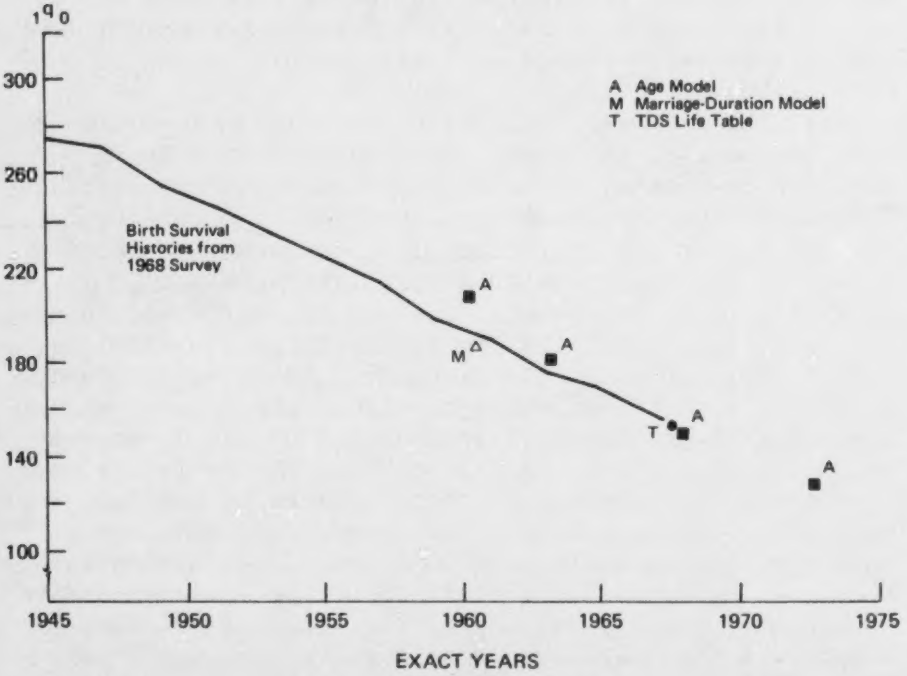


FIGURE 15 Early Childhood Mortality Expressed in Terms of Infant Mortality Rate, 1945-75 (per thousand): Turkey

Source: Tables 18 and 19.

model) are shown in Table 19 and plotted in Figure 15 together with the trend estimates derived from the birth-survival histories. Two points are plotted from the 1963 survey, both dated early 1960; the higher estimate is based on the Brass-Trussell age model and is comparable in terms of method of estimation with the other points shown as A. However, the basic data for the 1960 estimate were incomplete as explained earlier in this section. Fortunately, the 1963 national population survey contains data with which to bypass the problem. Tabulations were made of CEB and children who have died (CD) by the duration of marriage of women in the national sample. A variant of the Brass-Sullivan-Trussell method applies a marriage duration model to the data to reach an estimate of the infant mortality rate. The result is shown by the point M plotted in Figure 15. While this estimate is not comparable in method to the other points A, it is soundly based on a single sample of women (not mixed with census data), and may be interpreted as a lower-limit estimate for 1960.

Finally, the figure shows a single life-table estimate T of infant mortality from the TDS. Since this chart refers to mortality for both sexes combined, the infant mortality rates for each sex ($_1q_0$ in Table 16) are combined according to a sex ratio at birth of 105 males per 100 females. The resulting infant mortality rate of 153 per thousand is dated 1967.2 (the midpoint of the enumeration period).

Juxtaposing all these single-date estimates with the trend estimates strongly confirms the results of the Macura method of birth-survival histories for the period from 1960 to 1968. These favorable results create a presumption, although not complete assurance, that trend estimates for earlier dates derived by the same birth-survival method are also reliable. Going back as far as 1945 from 1968, the number of women old enough in 1968 to give reports diminishes, because the upper age limit for the survey was 45 years of age. Since these older women were having their first children at the early dates around 1945, and first-order children have higher risks of death than second and higher order children, the infant mortality experience reported by them is probably higher than for all children born during that early period. This could exert an upward bias on estimates at very early dates. No attempt was made to carry the trend back further than 1945.

Use of the Estimates in Multiple Reverse Projections

The child mortality trend estimates are important assumptions underlying the multiple reverse projection method described in Chapter 2. Since the projections are made by intercensal five-year periods, the necessary estimates are centered on exact between-census dates: 1938.3, 1943.3,...1973.3. For the period 1945-70 the centered estimates were computed from the trend shown in Table 18. For 1973.3, an estimate of 126 was obtained by extrapolation of less than one year from the Brass-Trussell estimate for 1972.7, which was based on the census of 1975. For years earlier than 1945, the assumptions for child mortality were derived from estimates of adult mortality by a procedure explained below in the section on general mortality.

INFANT AND EARLY CHILDHOOD MORTALITY BY DIVISIONS, 1945-67

The data and methods for examining differentials and trends in infant mortality by divisions are the same as those used for the national estimates. Since the data are mainly from surveys, although checked for some dates by census data, the material is less satisfactory for any single division than for the national estimates, due to the small numbers involved. In addition some special problems of interpretation that do not affect national estimates arise in the case of divisional estimates. The strategy of deriving divisional estimates, therefore, was to begin with preliminary estimates based on the birth-survival history method. These results were then checked against trends estimated from independent data by the Brass-Trussell method. Finally, a number of adjustments were made to handle the special problems that affect only the divisional estimates.

Preliminary Estimates

The estimates obtained by application of the birth-survival history method are shown without adjustment in Table 20. These estimates were compared with estimates derived by the Brass-Trussell method for the dates 1960, 1963, and 1967 by using values of the birth-survival estimates interpolated for the same dates.

TABLE 20 1945-70: Estimates of Infant Mortality by Divisions, Turkey

Exact Reference Date[a]	Urban (preliminary)			Rural		
	Istanbul and Izmir	Other West	Central and East	West	Central	East
1945	190	216	252	227	344	280
1947	181	208	241	221	330	277
1949	175	200	231	218	315	266
1951	164	194	221	209	297	261
1953	158	187	209	205	278	254
1955	149	180	201	200	258	245
1957	140	172	191	194	230	236
1959	130	163	180	190	208	228
1961	124	157	169	186	191	222
1963	114	146	159	178	173	206
1965	108	142	149	172	164	187
1967	100	135	140	166	155	166

Note: The urban estimates are preliminary, because they require adjustment as explained in the text and in Table 23. The rural estimates are accepted as explained in the text.

[a] See footnote a, Table 18.

Source: Based on birth-survival histories of 1968 Hacettepe survey.

The comparison is made after grouping the birth-survival history estimates into the three urban-rural divisions shown in Table 21 and plotted in Figure 16. Without exception, the independent sources confirm the existence of substantial rural-urban differentials. The downward trends are confirmed over all segments of time except one, the 1960-63 period for Istanbul-Izmir. There is no explanation for this anomaly in the data other than the ever-present possibility of error affecting one of the two data sources. The downward trend for Istanbul-Izmir is firmly supported, however, by comparing either of the first two paired estimates (1960 or 1963) with the paired estimates for 1967, which are clearly lower. The slope of the downward trend for Istanbul-Izmir is left in some doubt.

The independent estimates of 1963 for "other urban" and rural reflect a division between urban and rural at a population size of 2,000 instead of the 10,000 used in all the other data sources. This classification of rural, small-town populations as urban probably raises

TABLE 21 Infant Mortality Rates by Divisions from Birth-Survival Histories (BSH) Compared with Brass-Trussell Estimates from Various Sources, 1960, 1963, 1967: Turkey

	1960			1963			1967		
Division	BSH	Survey of 1963	Date of Estimate	BSH	TDS	Date of Estimate	BSH[a]	Census of 1970	Date of Estimate
Istanbul and Izmir	126	122	1960.4	114	128	1963.1	98	104	1967.6
Other Urban	168	179	1960.3	154	175[b]	1963.3	135	141	1967.7
Rural	202	217	1960.2	185	184[b]	1963.0	158	157	1967.7
National[c]	194	208	1960.1	178	180	1963.1	151	149	1967.7

[a] Extrapolated for fraction of year.

[b] The TDS division between rural and urban is 2,000 persons, whereas 10,000 applies to all other sources above.

[c] Note that the dating of estimates by divisions varies. The national estimates differ slightly from theoretical averages, which are birth-weighted means. Estimates were made separately for divisions and for the national total.

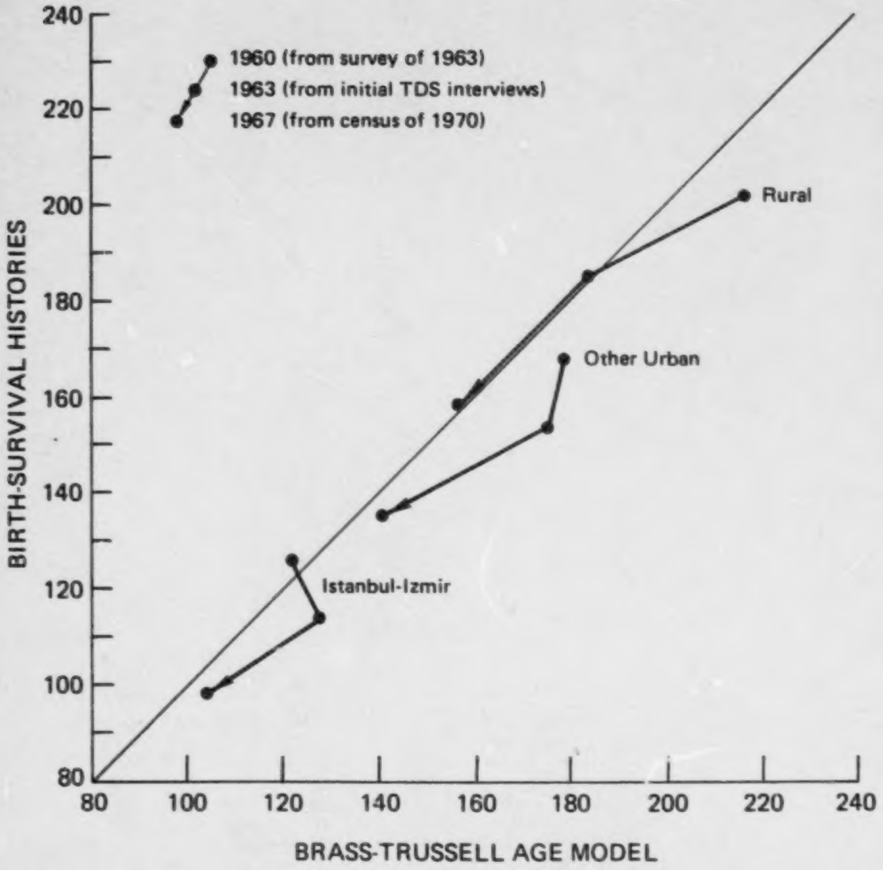


FIGURE 16 Comparison of Infant Mortality Estimates from Birth-Survival Histories with Independent Brass-Trussell Estimates by Rural-Urban Divisions (rates per thousand): Turkey

both the rural estimate of infant mortality and the "other urban" estimate. This could account for the leftward kink in the rural curve, but not the rightward kink in the "other urban" curve. Some error is evidently present in the data blurring the broad confirmation of trends.

Additional estimates for all six divisions were tested by the same procedure, and the results are shown in Figure 17. The effect of sampling error and other types of data error on estimates is bound to increase as smaller divisions are demarcated. For example, the independent estimates for "other urban west" show an

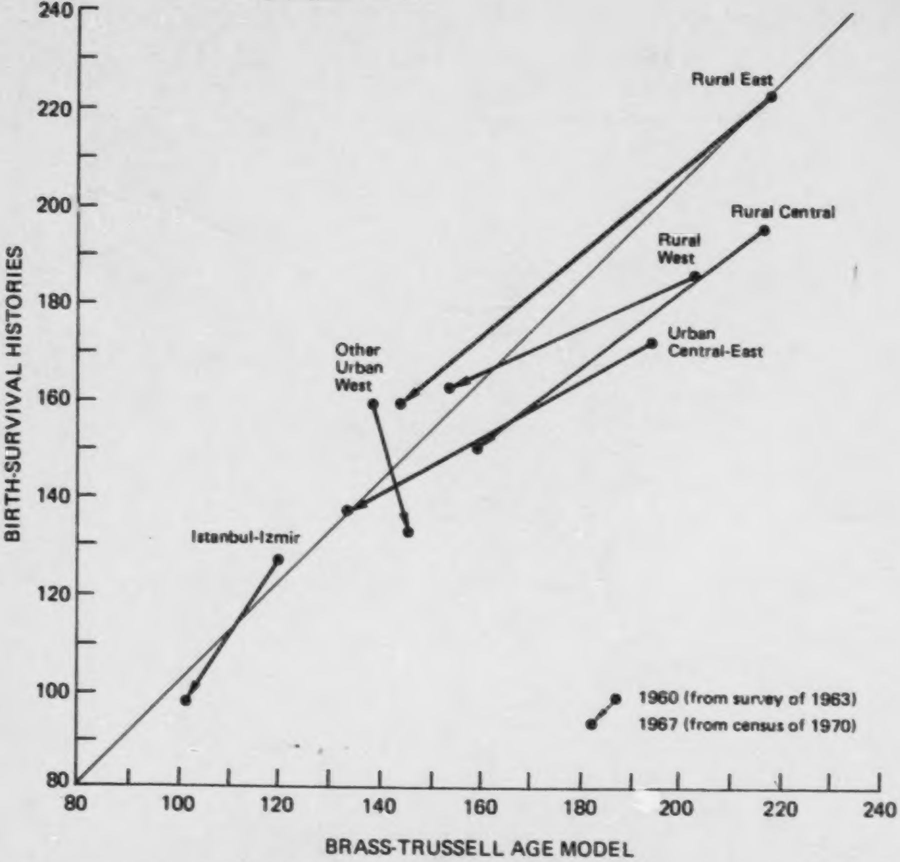


FIGURE 17 Comparison of Infant Mortality Estimates from Birth-Survival Histories with Independent Brass-Trussell Estimates by Regions within Rural and Urban Divisions (rates per thousand): Turkey

increase rather than a decline from 1960 to 1967. This raises a question about the direction of the trend; however, the consistent confirmation of downward trends in the other divisions argues for accepting the downward trend for "other urban west" as well. In all other respects, there is reasonable agreement among the estimates from the birth-survival histories and independent sources.

Data with which to make independent tests of the trends earlier than 1960 are not available. However, some value can be attached to the earlier estimates keeping in mind that divisional estimates are inherently less robust than national ones (sample size) and there remain some issues of interpretation to be discussed below. Furthermore, if the birth-survival histories are a reasonable basis for sketching the main outlines of mortality trends during the period for which they can be checked, they are likely to be valid for the earlier dates as well.

Adjusting for Rural Births and Deaths Reported by Urban Mothers

Measurement methods that look back in time from a survey carry with them the problem of allocating the births and deaths reported by mothers to the different divisions of the country. The mothers interviewed in 1968 are representative of mothers living in the divisions at that time; however some births and deaths of their children occur in different divisions if the mothers migrate after childbearing starts. In addition, some of the towns where the survey is conducted are urban at the time of the survey but were part of the rural division at an earlier date. These two circumstances create possibilities for measurement error that are discussed below. Neither type of error affects national estimates, because both involve allocating information about infant mortality between divisions, not its relevance to the country as a whole.

The Hacettepe tabulations of 1968 assign births and survival histories to the rural and urban divisions according to the mothers' place of residence in 1968. Tabulations for the independent Brass-Trussell estimates are also made in the same way in all sources. Thus, for example, the Ministry of Health's survey in 1963 (providing Brass-Trussell estimates for 1960) is tabulated according to residence in the rural and urban divisions of 1963.

Errors Due to Migration of Mothers

The first problem to take up, which applies equally to the birth-survival history method and the Brass-Trussell method, is the effect of rural-to-urban migration of mothers. Since the rural setting has higher infant mortality rates than the urban setting, the inclusion of rural birth-survival experience in the data for urban estimates causes an upward error for the urban division.

It is not clear whether omission of this rural mortality experience from the rural estimation procedure causes error in the rural division estimates as well. If the misallocated information refers to average rural experience, there will be no error in the rural estimate. If there is a difference, the practical effect is likely to be trivial, because the number of misallocated rural births is so small relative to total rural births in Turkey.

The likelihood of upward error in the urban estimates of infant mortality rests on three conditions that must all be present: higher rural than urban mortality rates, rural-to-urban migration by mothers, and pre-migration childbearing. All of these conditions are fulfilled in Turkey. It is necessary, therefore, to evaluate their importance in the Turkish setting during the period of estimation.

Some information on this point comes from a 1966 survey of women in Ankara city carried out by the Sociology Department of Middle East Technical University under the direction of David Goldberg. A well-designed representative sample of 803 women was interviewed. The survey occurred only two years prior to the 1968 survey that is the source of the birth-survival histories. The Ankara survey follows a decade of high rural-to-urban migration, about which more is said below. Adlakha (1970) makes use of migration information in the survey to divide the births by rural and urban settings. It is assumed that in most instances the mother did not bring the newborn child to the city immediately, so its survival experience during infancy and early childhood is assumed to belong to the setting of its birth.

Infant mortality rates are calculated in various ways, making it possible to isolate clearly the error that occurs when rural births are included in the urban data. For six years immediately preceding the Ankara survey, 8.5 percent of births were rural, leading to an infant mortality rate 5.0 percent higher than the "true" urban rate of 109 per thousand births. For an earlier period, 7 to 16 years preceding the survey (1950-59), the error is greater. Rural births were 27.3 percent of births reported for this period, and the infant mortality rate was 18.6 percent higher than the "true" urban rate of 133 per thousand births. In the Ankara study, "urban" was defined as the entire urban sector, not limited to Ankara city alone.

The higher degree of error for earlier dates is not intrinsic to the estimation procedure but is due to a different pattern of premigration childbearing at that time. As rural-to-urban migration picked up speed in Turkey, starting from modest levels in the 1940s (see Table 14) some women who had already started their childbearing migrated to the cities. During this period, women typically followed or joined their husbands in the city. In the 1960s, a new pattern was established wherein migrant women had all, or nearly all, of their children in the city after migration. This change was supported by a rising age of marriage for rural women and by the existence of more possibilities to marry "upward" to men who became established in ever increasing numbers in the cities. In addition, a second generation of "village" men became available as boys migrated in their teens to the homes of relatives in the cities and grew up there.

The Ankara study provides a standard by which to evaluate the error in mortality rates due to the rural-urban migration of mothers. Since migration is the cause of the error, migration rates for women aged 15-39 are a good indicator of the relative importance of the estimation error in different parts of the urban population. Detailed migration estimates by age and sex for Turkish cities are available for the decade 1955-65, a period that closely precedes the 1968 Hacettepe survey (Tekce, 1975). The female migration rate for ages 15-39 for Ankara was 61.5 per thousand annually, one of the highest city rates in Turkey, showing that the Ankara standard represents estimation error due to migration at its extreme. The general rate, for all cities over 10,000 population, was 25.9 per thousand. For Istanbul-Izmir and "other urban," the migration rates were 24.2 and 26.4, respectively. No further subdivision by urban regions was made.

Undoubtedly the relationship between a migration rate preceding a survey and the proportions and dating of rural births that are misallocated to the urban division is complex. Nevertheless, the assumption of a reasonably direct linkage is justified since the source and size of error are clearly tied to the proportion of women in the childbearing ages who are migrants. On this basis, the Ankara standard of error was assumed to be applicable as an adjustment factor, when multiplied by the ratio of the divisional migration rates to the Ankara migration rate. These ratios are shown below:

Istanbul-Izmir: $r = 24.2/61.5 = .393$
Other urban : $r = 26.4/61.5 = .429$

The standard (Ankara) migration errors in the mortality estimates, dated according to the period of birth and stated as proportions of the "true" infant mortality rate, are as follows:

Period of Birth	Standard (Ankara) Error
1950-59	.186
1960-65	.050

Since information on the extent of pre-migration childbearing is not available prior to the 1950s, it was assumed that the proportionate error is the same for 1945-50 as immediately thereafter. In order to indicate gradual changes in the extent of pre-migration childbearing over all the years for which adjustments are needed (1945-67), the standard was interpolated and extended a short distance at each end, as follows:

1945 to 1955	.186 (as estimated)
linear decrease to:	
1963	.050 (as estimated)
linear decrease to:	
1967	.025 (by assumption)

An adjustment multiplier, m, for application to the preliminary urban mortality rates was then calculated as follows:

$$m = 1/[1+(r)(s)]$$

For example, the multiplier for Istanbul-Izmir in 1945 is $1/[1 + (.393)(.186)] = .932$. The preliminary infant mortality rate of 190 per thousand is then adjusted by this multiplier to 177 per thousand. The adjustments for the urban divisions were carried out for all dates in the same way, after considering a second type of birth misallocation.

Errors Due to Transfer of Communities from Rural to Urban Status

Part of the urban sector in 1968 was still rural at earlier dates. Therefore, women residing in 1968 in places that had transferred from rural to urban status reported some births that were pre-transfer births. The proportion of urban births that are misclassified as rural births due to this change in status increases as estimates are made for dates further back in time. The Ankara study does not identify error of this type because all the interviews were held in Ankara city, which had been an urban place at all the earlier dates.

The rural places in 1945 that transferred to the urban sector by 1968 were listed and found to have a population of approximately .50 million in 1945 as compared with an urban population of 3.44 million at that time. The relationship between these two population sizes immediately suggests that the allocation of rural births to the urban sector in 1945 by reports of women in 1968 is not small. Table 22 presents an approximation of the error in 1945 made on the basis of some simple and plausible assumptions. The column on the rural sector is included not out of necessity for the computations but to draw attention to the large size of the rural sector in terms of births and deaths relative to the size of the urban sector at that time.

The effects of community transfers are evaluated for the urban sector as a whole, because records for Istanbul and Izmir to trace the transfer of rural communities into the urban sector and from there to annexation by expansion of the municipal boundaries are not available. The Istanbul-Izmir division is defined by its municipal boundaries at the different dates of the study. The results of the computation at 1945 show that the migration-adjusted mortality rate for all urban areas must be adjusted additionally for community transfers by a multiplier as follows (Table 22):

$$(\text{line } 8) \;/\; (\text{line } 5) = 193 \;/\; 213 = .906.$$

Since this cause of error approaches zero as the date of the estimate approaches the survey date, a linear interpolation from .906 to 1.000 from 1945 to 1967, respectively, was used to provide a multiplier for each date. These multipliers are shown in column t, Table 23.

Final Estimates

The final adjustment of the urban trends of infant mortality, consisting of an adjustment for both migration of mothers and transfers of communities, is shown in

TABLE 22 Adjustment of Urban Infant Mortality Rate for Transfer of Rural Communities to Urban Sector, 1945: Turkey

Situation in 1945	Rural	Urban
Actual situation in 1945		
1. Population (millions)	15.35	3.44
2. Crude birth rate (per thousand)	49.4	26.6
3. Births (thousands)	758.3	91.5
As seen from 1968		
4. Births (thousands)	733.6	116.2
5. Migration-adjusted infant mortality rate (per thousand)	287	213
6. Deaths up to age 1 (thousands)	210.5	24.8
Actual mortality in 1945		
7. Deaths up to age 1 (thousands)	217.6	17.7
8. Infant mortality rate (per thousand)	287	193

Notes

Line 1: From Table 9.

Line 2: The birth rates are population-weighted means calculated for rural and urban from Table 11. The birth rates themselves are estimated utilizing infant mortality as a parameter. A trial value for urban infant mortality was computed in the format of the present table, followed by revision of the crude birth rate and a second trial. This process of successive approximation was repeated until mutually consistent adjusted mortality rates (Table 23) and crude birth rates (Table 11) were reached. The convergence was rapid because the crude birth rate is estimated with a second independent parameter, C(10), which has a strong effect on the final estimate of the crude birth rate.

Line 3: (1) x (2).

Line 4: Reflects transfer of rural births from rural to urban, .5 x 49.4 = 24.7.

Line 5: The rural mortality rate does not require adjustment. The urban mortality rate comes from the original unadjusted mortality rates adjusted for migration as explained in the text. The migration-adjusted urban mortality rate used here is the birth-weighted mean of the urban divisional mortality rates.

Line 6: (4) x (5).

Line 7: Reflects transfer of misallocated rural deaths from urban to rural, 24.7 x .287 = 7.1.

Line 8: (7)/(3).

Table 23. As explained above, the rural estimates do not require adjustment, so they are the same as those in the rural columns of Table 20.

The general pattern of differentials and trends across divisions, shown in Figure 18, may be accepted as valid, but there should be skepticism about specific values at particular dates. The picture is one of much higher rural than urban infant mortality at the earliest dates.

TABLE 23 Urban Infant Mortality Rates Adjusted for Reporting Error Due to Migration of Mothers and Transfers of Communities from Rural to Urban, 1945-67: Turkey

Exact Reference Date[a]	Adjustments		Istanbul and Izmir	Other Urban West	Urban Central and East
	s	t			
1945	.186	.906	160	181	211
1947	.186	.915	154	176	204
1949	.186	.923	151	171	197
1951	.186	.932	142	167	191
1953	.186	.940	138	163	182
1955	.186	.949	132	158	177
1957	.152	.957	126	155	172
1959	.118	.966	120	150	166
1961	.084	.974	117	148	159
1963	.050	.983	110	141	153
1965	.038	.991	105	138	145
1967	.025	1.000	99	134	139
			r = .393	r = .429	r = .429

Note: The multiplier is: $M = [1/(1 + rs)] \times t$, where s is the standard, r is the ratio for the division to the standard, and t is the adjustment for community transfers from rural to urban. See text for details and an example of the calculations.

[a] See note a, Table 18.

The rural mortality rates are spread across a large range with especially high mortality rates in the central part of Turkey. Estimates for the eastern rural area, which includes the southeast, are not the highest even though social indicators consistently rank this rural region lowest in Turkey during the period evaluated here. The rate of decline of mortality rates, however, is most rapid in the central region. By the 1960s, rural differentials essentially disappear across all three regions. This equalization, however, is not accomplished by reaching what would be considered "low" levels of infant mortality in all divisions, because even levels on the order of 160 per thousand (the combined rural estimate in 1967) certainly must be regarded as still high. Small differences among the rural regions and rearrangements of rank order at the end of the period are not significant, because the strength of the data cannot support precise measurement. The general rural pattern, and the convergence of rural trends by the mid-1960s, are acceptable findings.

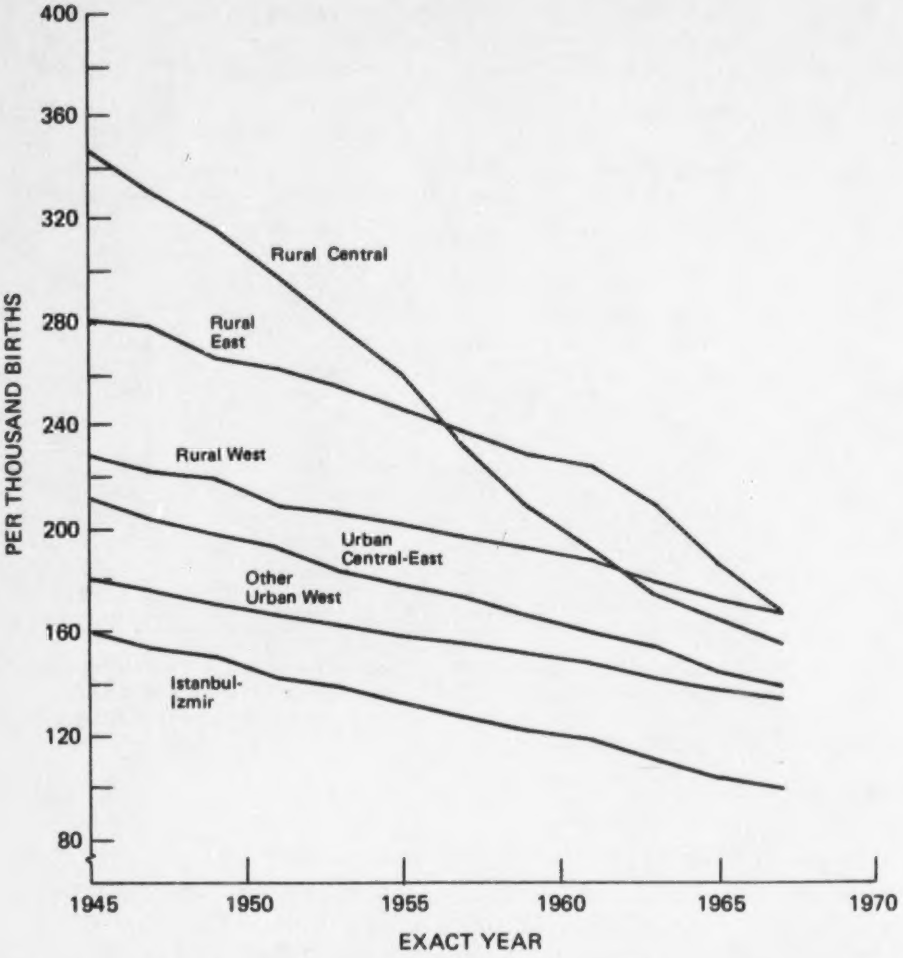


FIGURE 18 Infant Mortality Rates by Divisions, 1945-67: Turkey

Urban mortality rates declined more slowly than the rural ones and there was little change in the urban differentials across regions. Infants and young children continued to survive in 1967 more successfully if born and reared in a metropolitan city than in rural or less urban communities, just as was true two decades earlier.

Infant Mortality by Province

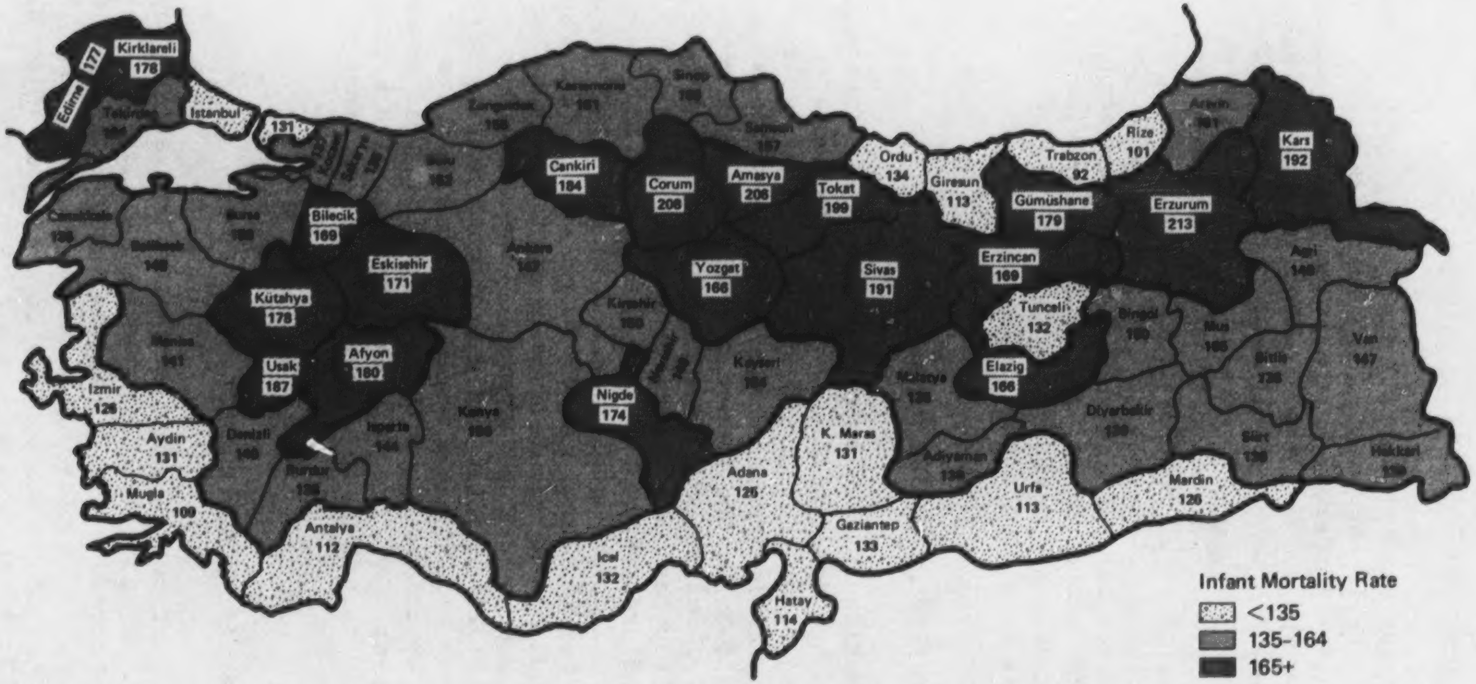
The 1970 census was tabulated and published by province. It included the "Brass questions," which are used to estimate infant mortality by the Brass-Trussell method. Since the census volumes also present the data separately for the rural and urban populations, a rather finely drawn picture can be produced of infant mortality at the provincial level. Variation in age misstatement and completeness of reporting for children born who died following birth are sources of error. A map of the results (Figure 19) and the more detailed presentation for rural and urban separately (Table 24) provide unusual and valuable material for use in conjunction with other social data at the provincial level.

Infant Mortality by Social Class

Some information is available regarding infant mortality differences by social class, but it is limited in coverage and time. The Ankara study (Adlakha, 1970) makes a distinction between upper and lower status women. In 1950-59, the two status groups accounted, respectively, for 35 percent and 65 percent of total births. The urban infant mortality rates were 93 and 149 per thousand, respectively. For the next period, 1960-65, the infant mortality rates by social status were 47 and 123 per thousand, respectively. (Some farmers were left out of the tabulations by social status, so these data are not fully comparable with the urban mortality estimates cited above from the Ankara survey.) When differences of infant mortality by social status are this large by comparison with the divisional differences, it is apparent that more information classified by social status would be useful to detect mortality differentials in Turkey.

NATIONAL MORTALITY ABOVE AGE 5, 1935-75

The method most suitable for estimating mortality above age 5 in Turkey is forward projection, utilizing a cumulation procedure that minimizes the effects of age misreporting. In a closed population an intercensal life table from childhood onwards may be estimated "directly" by tracing birth cohorts from one census to the next.


Edirne
177
Kirklareli
178
Istanbul
131
Zonguldak
Kastamonu
161
Sinop
Samsun
157
Canakkale
Bursa
Balikesir
Bilecik
169
Cankiri
184
Corum
208
Amasya
206
Tokat
199
Ordu
134
Giresun
113
Trabzon
92
Rize
101
Artvin
161
Kars
192
Gümüshane
179
Erzurum
213
Ankara
147
Eskisehir
171
Kütahya
178
Manisa
141
Usak
187
Afyon
180
Izmir
126
Aydin
131
Denizli
Isparta
144
Burdur
Mugla
100
Antalya
112
Konya
Kirsehir
Yozgat
166
Sivas
191
Erzincan
169
Tunceli
132
Bingol
Mus
Agri
Van
147
Bitlis
Nigde
174
Kayseri
Malatya
Elazig
166
Diyarbakir
Siirt
Hakkari
Adiyaman
K. Maras
131
Adana
126
Icel
132
Hatay
114
Gaziantep
133
Urfa
113
Mardin
126
Infant Mortality Rate
<135
135-164
165+

'IGURE 19 Infant Mortality Rates by Provinces, 1967 (per thousand population): Turkey

These estimates will be correct only if the population is truly closed, the two censuses have the same level of completeness, and there is no age misreporting. In actual populations these assumptions rarely hold simultaneously. Yet, by combining these ideas with their model life-table system, Coale and Demeny (United Nations, 1967) devised a technique that attempts to identify the mortality level to which a population is subject on the basis of intercensal comparisons. This technique assumes that the age pattern of mortality in the observed population conforms to a selected mortality pattern from a family of model life tables such as those of Coale and Demeny (1966).

Once a pattern has been selected, the population enumerated at the first census is projected to the time of the second census (forward projection) by using survival rates derived from a range of mortality levels from the chosen family of model life tables. For each age x, a model life table is selected that reproduces by forward projection exactly the observed population over age x+t at the second census (t being the length of the intercensal interval). A representative mortality level is then chosen, generally by taking the median of the life tables selected to match the populations projected above the ages 5, 10, ... 40, 45. Because the population is cumulated in each projection for ages x and over, rather than handled separately by five or ten-year cohorts to estimate mortality levels, the effects of age reporting errors are minimized though not necessarily eliminated. The estimates yielded by this technique are generally acceptable, but they are sensitive to differential completeness of enumeration between the censuses used.

The method is at its best when the intercensal interval is 5 rather than 10 years, and it can provide estimates when satisfactory death registration data are not available. Both of those conditions prevail in Turkey and have made the method particularly suitable (Demeny and Shorter, 1968). The data requirements are a series of censuses and information on international migration. The latter is used to adjust the initial (or terminal) census in each five-year pair of censuses so that the two censuses represent a population closed to migration. After this adjustment, the only remaining source of population change above age t is mortality, which is estimated by the forward projection technique.

TABLE 24 Infant Mortality and Fertility Indexes by Province, Circa 1967 and 1960: Turkey

	Infant Mortality, Around 1967 (per thousand births)			Fertility, Around 1960	
Province	Rural	Urban	Total	CBR (per thousand)	TFR (per woman)
(1)	(2)	(3)	(4)	(5)	(6)
1 Adana	128	123	125	46.7	7.10
2 Adiyaman	136	148	139	58.4	7.97
3 Afyon	189	149	180	49.2	6.91
4 Agri	149	146	148	59.9	9.19
5 Amasya	218	174	206	41.1	5.67
6 Ankara	177	134	147	40.5	5.52
7 Antalya	110	118	112	46.5	6.68
8 Artvin	165	136	161	44.8	6.15
9 Aydin	137	117	131	35.5	4.75
10 Balikesir	160	121	148	35.5	4.83
11 Bilecik	173	162	169	35.8	4.72
12 Bingol	146	170	150	63.5	9.40
13 Bitlis	134	140	136	65.0	10.10
14 Bolu	157	130	152	40.9	5.65
15 Burdur	144	123	138	41.0	5.83
16 Bursa	173	138	158	33.9	4.45
17 Canakkale	142	116	136	32.4	4.52
18 Cankiri	192	149	184	52.6	7.10
19 Corum	215	181	208	50.5	6.74
20 Denizli	148	118	140	42.1	5.68
21 Diyarbakir	136	144	139	56.4	8.59
22 Edirne	190	149	177	37.4	5.19
23 Elazig	164	167	166	55.5	7.86
24 Erzincan	173	157	169	53.8	7.74
25 Erzurum	214	210	213	51.4	7.32
26 Eskisehir	195	146	171	40.7	5.71
27 Gaziantep	133	132	133	48.0	6.86
28 Giresun	115	104	113	53.7	7.27
29 Gumushane	182	159	179	53.8	6.78
30 Hakkari	140	136	139	67.7	10.56
31 Hatay	120	105	114	50.7	7.68
32 Isparta	158	116	144	40.0	5.86
33 Icel	141	122	132	43.8	6.54
34 Istanbul	135	126	131	23.1	3.04
35 Izmir	130	121	126	29.8	3.99
36 Kars	197	170	192	58.0	8.84
37 Kastamonu	168	122	161	40.3	5.43
38 Kayseri	175	146	164	52.3	7.35
39 Kirklareli	196	140	178	35.1	5.13
40 Kirsehir	156	128	150	59.3	8.51
41 Kocaeli	143	131	137	35.1	4.96
42 Konya	167	142	159	51.3	7.37
43 Kutahya	183	159	178	37.2	4.84
44 Malatya	139	129	135	56.7	8.14
45 Manisa	145	132	141	36.1	4.93

TABLE 24 (continued)

	Infant Mortality, Around 1967 (per thousand births)			Fertility, Around 1960	
Province	Rural	Urban	Total	CBR (per thousand)	TFR (per woman)
(1)	(2)	(3)	(4)	(5)	(6)
46 Maras	131	131	131	55.1	8.01
47 Mardin	125	129	126	60.1	8.65
48 Mugla	112	92	109	40.1	5.71
49 Mus	158	143	155	64.5	9.61
50 Nevsehir	151	142	149	54.1	7.54
51 Nigde	179	157	174	54.7	7.76
52 Ordu	137	121	134	58.8	7.49
53 Rize	101	101	101	52.1	7.05
54 Sakarya	139	127	136	40.3	5.72
55 Samsun	160	147	157	46.7	6.51
56 Siirt	142	134	139	61.9	8.98
57 Sinop	165	124	159	45.3	6.34
58 Sivas	198	170	191	54.6	7.44
59 Tekirdag	175	142	164	35.1	5.05
60 Tokat	207	174	199	51.1	6.96
61 Trabzon	91	96	92	53.1	7.20
62 Tunceli	135	123	132	63.2	9.41
63 Urfa	109	118	113	56.8	8.15
64 Usak	198	164	187	42.4	5.66
65 Van	155	127	147	63.5	9.52
66 Yozgat	169	149	166	54.0	7.54
67 Zonguldak	167	124	155	41.8	5.90
Total	157	134	149	45.1	6.30

Effects of International Migration

Between 1935 and 1960, the balance of international migration was positive, due to the relocation in Turkey of small Turkish populations from the Balkan countries. After 1960, Turkish workers were attracted in great numbers to West European labor markets, primarily West Germany, and the balance of migration became negative. Statistics on these movements, presented in Appendix D, are adequate to describe general orders of magnitude but are not of high quality. Statistics on total migration by sex are more reliable than those that describe the distributions by age. Fortunately, the forward projection method is not affected seriously by errors in the age distributions, because this form of error is similar to age misstatement. The forward projection method uses a cumulation procedure that minimizes estimation error caused by age mistatement.

Age Pattern of Mortality Above Age 5

Model life tables that represent the age pattern of Turkish mortality above age 5 are needed in the forward projection method of mortality estimation. Once again, the life table of the Turkish Demographic Survey was used to choose among the Coale-Demeny regional families, which are indexed by level numbers. The choice is made by examining the levels within a family that exactly match the expectations of life at each age from age 5 upward. The relevant range for matching is from age 5 to 45, because the forward projection method cumulates the projections of deaths and survivors from ages within this range to the end of life. Some differences from actual age patterns of the selected model family above age 45 are tolerable so long as the cumulative measure, e_x, within the range x=5 to 45, matches well.

The goodness of fit of each family is shown by the chart in Figure 20. A precise horizontal line indicates a perfect fit of the family to the Turkish life table. The chart is constructed by calculating an index of fit, R_x:

$$R_x = (\text{Level at } e_x) \div (\text{Level at } e_5)$$

The Coale-Demeny families of models are indexed continuously from 1 to 24 within a family, the level number rising with increased expectation of life. At each value of e_x in the Turkish life table there is a unique model level in the family of models in question that has the same value of e_x. These unique matches are found for each value of e_x and divided in the expression above by the model level at e_5. Thus, the index of fit R_x takes a value of 1.0 at age 5 by definition. At higher ages R_x varies for each family and sex.

"East" fits marginally better than "West," particularly for females, but there is little overall difference in goodness of fit between the two. The other two families are clearly less good matches. The choice of the "East" family above age 5 is independent of the choice made earlier to use "East" for infant and early childhood mortality. The model levels, as well as the

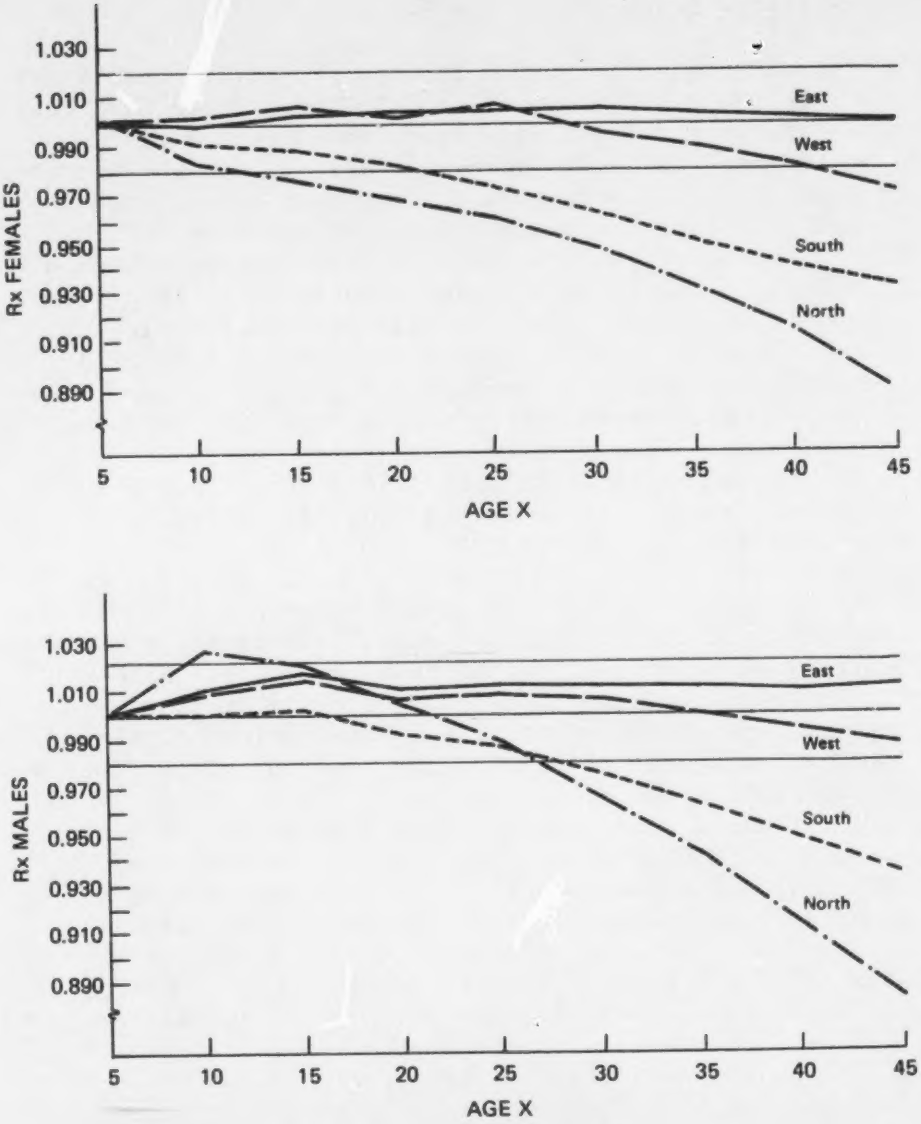


FIGURE 20 Comparison of Mortality Above Age 5 in Turkish Life Tables with Four Families of Model Life Tables: Turkey

families, were finally selected independently for adult and child mortality and then joined to form unique "split-level" models, as explained in the next section. Here, for adult mortality estimates, only the choice of a family above age 5 is needed.

Mortality Estimates Above Age 5

The results of applying the forward projection method are shown in Table 25, columns 2 and 3, and plotted in Figure 21. Estimates for a single intercensal period are sensitive to changes in census coverage, because increases in coverage cause survivorship to appear higher than it is and decreases in coverage have the opposite effect. Over a number of periods the total increase or decrease in census coverage can be assumed to be small even though estimates for particular five-year periods are elevated or depressed in irregular sequences. It is justified, therefore, to arrive at measures of a trend by smoothing with a graphing procedure, which is shown by the dashed line in Figure 21 and in columns 4 and 5 of Table 25.

Estimates through 1950 were allowed to stand without smoothing, because it is very likely that death rates were indeed higher in the 1940-1945 period than in earlier and later periods. From 1939 to 1946, Turkey faced several epidemics and severe shortages of food, especially in the cities, and a scarcity of drugs (Turkey, Ministry of Health and Social Welfare, 1973). Although estimates of mortality levels cannot be made from such information, the decrease in the expectation of life could be explained by such factors instead of by changes in census coverage.

For periods after 1950, a smooth trend can be graphed without difficulty except for the last five-year period, 1970-1975. The forward projection estimate for males appears to be unusually high relative to the previous period and relative to the gain in life expectancy measured for females. Several types of data error could be responsible, including migration error and an increase in census coverage as compared with 1970. For example, if the balance of male migration were assumed to be zero instead of -248,000 (Appendix Table D-1), the estimate of expectation of life at age 5 would drop from 69.7 years to 65.3 years.

At the time of the 1975 census (October), many Turkish males had not returned to their jobs in West Germany following the summer holidays. The economic recession in West Germany at that time caused restrictions and reduced incentives for workers to move there for jobs. The West German data on workers (see Appendix D) are not altogether adequate to date the worker flows. To the extent that Turkish workers are counted as outmigrants (part of the stock in Germany) and are enumerated at the same time in

TABLE 25 Estimates of Mortality Above Age 5 by Forward Projection, 1935-75: Turkey

Dating of the Estimate	Expectation of Life in Years at Age 5, "East" Models			
	Preliminary Estimates by Forward Projection		Final Estimates by Graphing	
	Males	Females	Males	Females
(1)	(2)	(3)	(4)	(5)
1935-40	51.4	50.2	51.4	50.2
1940-45	47.6	47.9	47.6	47.9
1945-50	56.9[a]	57.1[b]	53.1	54.0
1950-55	56.9[a]	57.1[b]	57.8	59.1
1955-60	63.4	64.8	60.4	61.9
1960-65	60.4	61.2	62.3	63.8
1965-70	61.5	64.3	63.5	65.5
1970-75	69.7[b]	67.1[b]	64.3	66.6

[a] A ten-year estimate was made in order to avoid using the 1950 census, which appears to have lower coverage of males and higher coverage of females than the previous or following censuses, causing disturbances in the orderly trend of estimates. The five-year points were then interpolated before making the final estimates by graphing.

[b] See discussion in text.

the de facto Turkish census, an upward bias is given to the estimated expectation of life at age 5 for 1970-75.

Another piece of evidence that weighs in the judgment about recent levels of mortality above age 5 is the life table being used, one based on TDS data for 1966-67 (Table 16). The life table shows an expectation of life at age 5 of 62.7 years for females and 60.2 years for males. The reference period is a year centered on 1967.2. For that same date the graphed estimates (after smoothing) in Figure 21 are 65.0 for females and 63.2 for males. The TDS evidence weighs against accepting higher estimates for life expectancy than the graphed trend. Since the life table provides estimates for one date only, rather than successive estimates over time by a comparable method, some difference between the level of the TDS estimates and the level of the trends graphed in Figure 21 is acceptable.

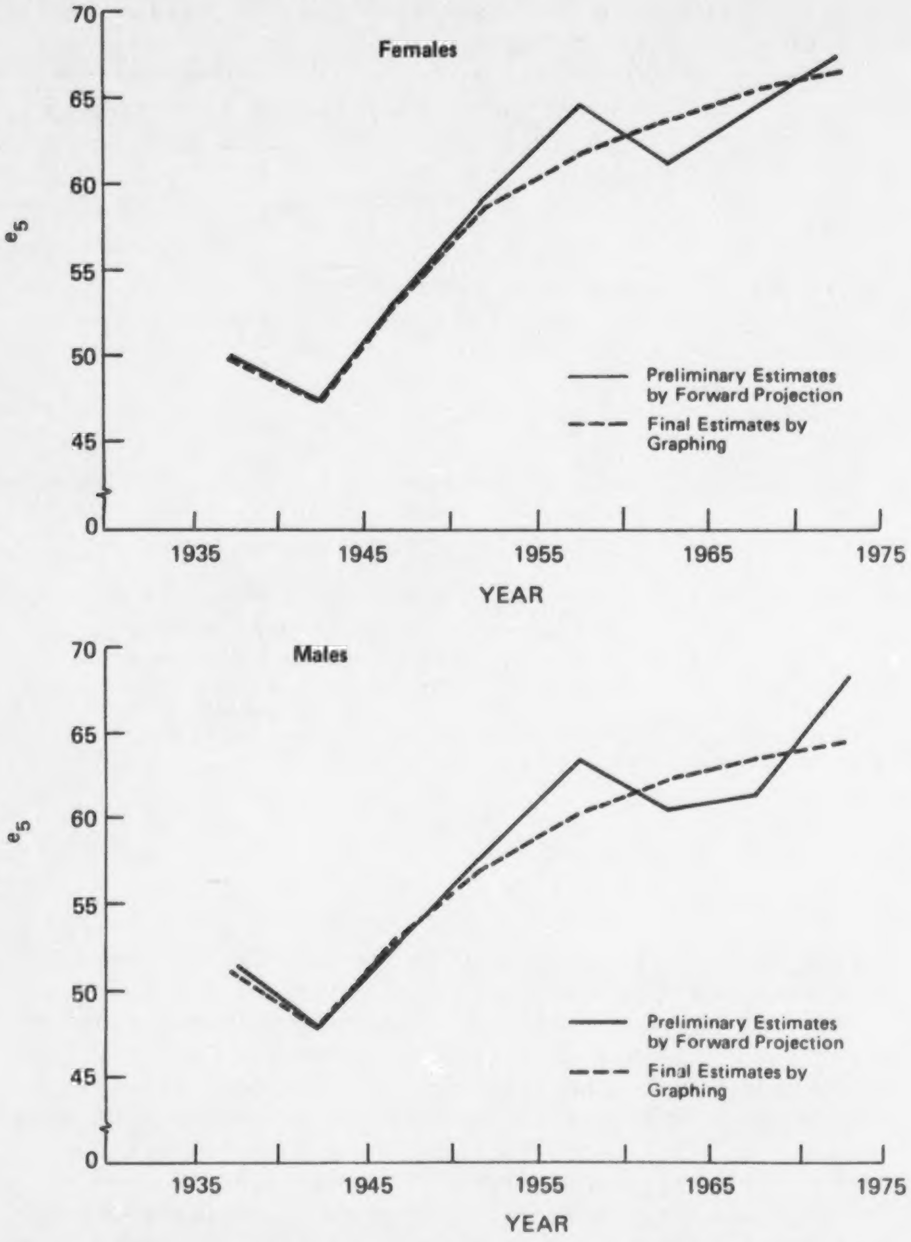


FIGURE 21 Estimates of Mortality Above Age 5 by Forward Projection, 1935-75: Turkey

NATIONAL GENERAL MORTALITY, 1935-75

While estimates of infant mortality and mortality rates above age 5 are valuable in themselves, the purpose of the following sections is to derive combined measures that express the general mortality of the population as a whole. This is done by constructing complete life tables for various dates that may be accepted as representative for the population as a whole.

Expectation of Life at Birth

The most general index of mortality is the expectation of life at birth, e_o, which summarizes the average survival experience of persons born into the population up to the end of life. Estimates of infant and early childhood mortality are joined with estimates of mortality above age 5 to form this general index. In effect, two life-table segments, one representing child mortality and one representing adult mortality, are joined to form a single life table that describes mortality in its entirety.

Numerically, the procedure is to utilize the following definition from the life table (radix = 1.):

$$e_o = {}_5L_o + T_5 = {}_5L_o + l_5 \times e_5$$

where ${}_5L_o$ and l_5 are from the life table representing mortality below age 5 and e_5 corresponds with a life table above age 5. As an example, the calculations for 1970-75 are shown below.

The index for child mortality is an infant mortality rate (${}_1q_o$) for both sexes combined of .126. This rate corresponds with a particular "East" model life table from which the corresponding indexes for ${}_5L_o$ and l_5 are derived for each sex separately (radix = 1.). The "East" model relationship of the sexes is assumed.

Index	Females	Males
${}_5L_o$	4.357	4.244
l_5	.8456	.8219

The measures of e_5 by sex for 1970-75 are from Table 25: 66.6 years for females and 64.3 years for males.

(1) e_o (females) = 4.357 + (.8456)(66.6) = 60.7
(2) e_o (males) = 4.244 + (.8219)(64.3) = 57.1
(3) e_o (both sexes) = [60.7 + (1.05)(57.1)] ÷ 2.05 = 58.9

The final equation for both sexes (3) recombines child mortality and exactly eliminates the "East" model assumption about sex differentials. The estimate resting most firmly on Turkish data, therefore, is the expectation of life at birth for both sexes combined.

Inspection of the actual sex differential in child mortality at the national level shows a difference from "East." In Table 26 the proportions of each sex dying up to ages 1 and 5 are taken from the 1966-67 life table. As in most populations, male mortality rates are higher in Turkey than female rates. However, they are not quite as much higher as the "East" model relationship predicts. Compared with the "East" populations (historical life tables of central and eastern Europe; north and central Italy), Turkish female infants and young children have lower survival rates. Consequently, there is a slight upward bias in estimates of e_o for females, and a corresponding downward bias for males. The bias calculated for 1966-67 is +0.2 years for females; for males it is -0.2 multiplied by the reciprocal of the sex ratio at birth. The bias at other dates is not known. For both sexes combined, however, no such bias exists (Table 27).

TABLE 26 Sex Differentials in Infant and Early Childhood Mortality Compared with Differentials Predicted by the "East" Models: Turkey

	Proportions Dying Up to Age x (${}_xq_o$)		
	TDS Life Table		
Age x	Females	Males	Males Predicted by "East" from Females
1	.144	.162	.172
5	.192	.213	.219

TABLE 27 Expectation of Life at Birth, 1945-75: Turkey

Period	Females	Males	Both Sexes
1945-50	39.6	36.7	38.1
1950-55	45.2	42.0	43.6
1955-60	49.7	46.5	48.1
1960-65	53.7	50.5	52.1
1965-70	57.4	53.9	55.6
1970-75	60.7	57.1	58.9

Deviant Child-Adult Age Pattern

Although the age pattern of Turkish mortality is well represented by the model life tables within the age ranges below and above age 5, the overall Turkish relationship of child to adult mortality deviates markedly from the "East" pattern. This can be seen by noting the infant mortality rate that is predicted by the model life table from the known expectation of life at age 5, or by making the prediction starting from infant mortality as the known value. These two ways of viewing the deviant character of Turkish mortality are shown in Figure 22.

None of the four families of model life tables closes the gap displayed in the figure. The "South" models are somewhat closer to the Turkish child-adult relationship, but still far removed (Demeny and Shorter, 1968). It must be concluded, therefore, that high Turkish death rates in infancy and early childhood, as compared with mortality at higher ages, exceed the "normal" bounds observed in the history of Europe and other now-developed countries that are the basis for the Coale-Demeny models. This in no way damages the estimates made above of child, adult, and general mortality, because the models are used independently above and below age 5.

The deviation from "normal," taking "East" as a standard of normal, increases from the date of the first available measurement (1945-50) until around 1960. It peaks in 1960-65 by one index and in 1955-60 by the other. Thereafter the gap diminishes. Thus, it is evident that the decline of child mortality lags behind

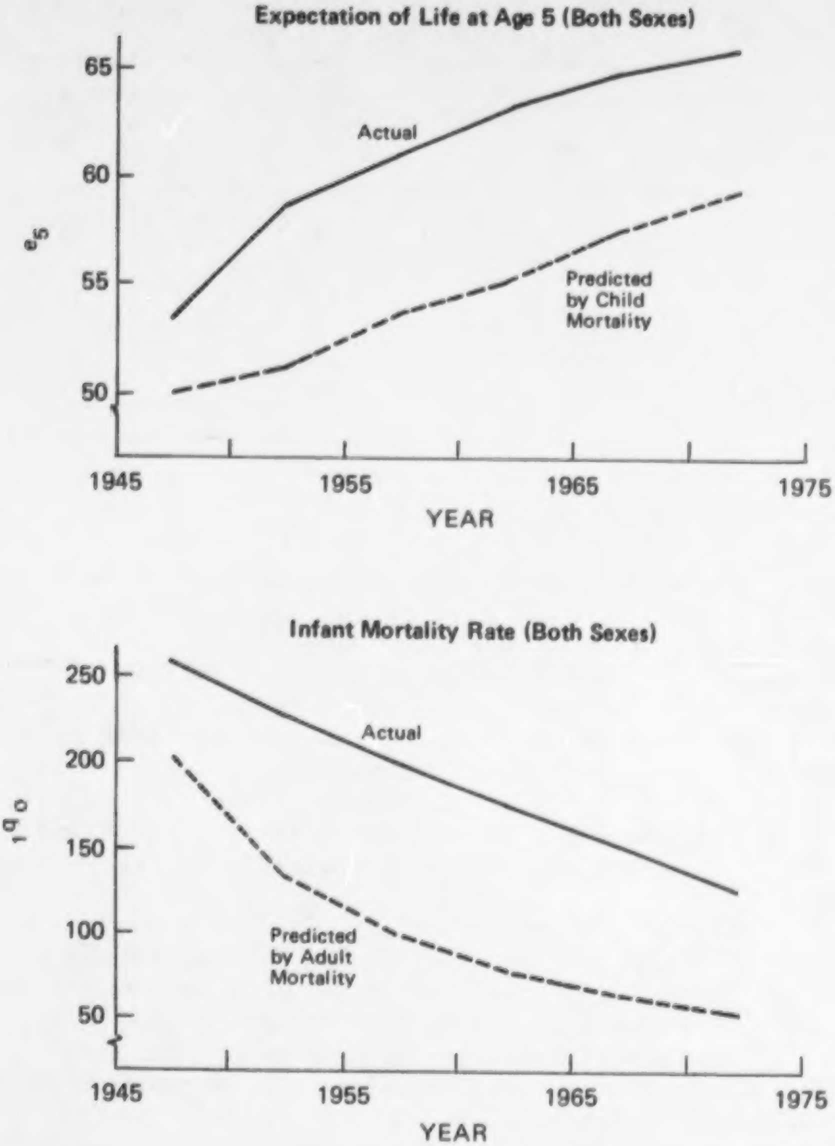


FIGURE 22 Changes in the Deviant Child-Adult Pattern of Turkish Mortality, 1945-75: Turkey

that of adult. The size of the gap may be interpreted as a measure of the inequality in health status between children and older persons, relative to an "East" historical standard.

Assumptions for Multiple Reverse Projections

The mortality assumptions needed for multiple reverse projections are now in hand for 1935 to 1975, excepting only infant and early childhood mortality for the earliest ten years, 1935 to 1945. The relationship of adult to child mortality just noted provides a basis for carrying the infant mortality assumptions back to this early period. The measured gap, in terms of the index $_1q_0$ in Figure 22 expands from .054 in 1945-50 to .103 in 1955-60, doubling in ten years. A simple reverse extrapolation to about one-half the initial value for ten years earlier in 1935-40 justifies an assumed gap at that time of .025. During the war years, 1940-45, very high adult mortality presumably caused the child-adult gap to disappear temporarily, so no gap is assumed. Based on these plausible assumptions the levels of infant mortality implied by adult mortality in 1935-40 and 1940-45 respectively were 273 and 306 per thousand assuming the relations of the "East" family of life tables. These assumed values for infant mortality complete the estimates needed as assumptions for the multiple reverse projections and are shown in Table 28.

TABLE 28 National Mortality Assumptions of the Multiple Reverse Projections, 1935-75: Turkey

Reverse Projection Period	Infant Mortality Rate, Both Sexes (per 1000 births)	Expectation of Life at Age 5 (years)		Both Sexes e_0
		Males	Females	
1970-75	126	64.3	66.6	58.9
1965-70	151	63.5	65.5	55.6
1960-65	176	62.3	63.8	52.1
1955-60	203	60.4	61.9	48.1
1950-55	233	57.8	59.1	43.6
1945-50	260	53.1	54.0	38.1
1940-45	306	47.6	47.9	31.4
1935-40	273	51.4	50.2	35.4

Source: Tables 18 and 25; see related text.

4 National Population Growth, 1935-75

Estimates from the preceding chapters are now brought together to describe the general process of population increase at a national level.

COMPONENTS OF POPULATION INCREASE

Changes in population size (p) are determined by the net effect of three components of change: births (b), migration (m), and deaths (d). Each of these components can be expressed as an annual rate of change in population size. The rates are additive when defined as geometric rates of increase: $p = b + m - d$. This equation provides a convenient basis for discussing the components of population increase.

Births and Migration

The rate of increase in population due to births, b, is the same as the crude birth rate. The rate of population change due to migration, m, is calculated from estimates of international migration (Appendix Table D-2) divided by the geometric midperiod means of population size according to the censuses (Table 1). These results are shown in the first two columns of Table 29.

Deaths

The third component, deaths, is measured by two alternative approaches. The first approach is to calculate the intercensal rate of population increase

TABLE 29 Rates of Population Change and Two Alternative Estimates of the Death Rate, 1935-75: Turkey

Period of Estimate	Rates of Population Change				Based on p from Reverse Projections	
	Births b	Migrations m	Increase p	Deaths d Est. I	p[a]	d Est. II
	(1)	(2)	(3)	(4)	(5)	(6)
1935-40	45.8	1.5	17.3	30.0	15.9	31.4
1940-45	43.3	.3	10.6	33.0	9.7	33.9
1945-50	46.0	.3	21.7	24.6	19.3	27.0
1950-55	48.3	1.3	27.8	21.8	26.1	23.5
1955-60	47.0	1.0	28.5	19.5	28.2	19.8
1960-65	43.2	-1.3	24.6	17.3	25.5	16.4
1965-70	38.8	-2.1	25.2	11.5	23.2	13.5
1970-75	34.9	-2.0	24.3	8.6	21.3	11.6

[a] The reverse projections are made from reported age distributions, except 1970-75, which is from an adjusted age distribution of a 1 percent sample of the 1975 census.

(from the population totals of Table 1), which gives p, shown in column 3 of Table 29, and then to utilize the equation, $d = b + m - p$. This first procedure yields Estimate I, shown in column 4 of Table 29.

The second approach is to utilize the rates of population increase implied by the multiple reverse projections (column 5 of Table 29) in the estimating equation. The result is Estimate II (shown in column 6). The two series of estimates are compared in Figure 23.

Each series of estimates has strengths and weaknesses. Estimate I errs in a downward direction whenever there is a relative increase in census coverage from one census to the next, because that raises p (column 3) erroneously. The upward kink in the curve of Estimate I at 1960-65 could be due to a decrease in census coverage in 1965 or to an increase in census coverage in 1970 (and 1975) relative to 1960. The reverse-projection estimates do not have this particular problem because, as explained in Chapter 2, each projection is made from a single census and therefore produces estimates that are independent of changes in census coverage.

In the reverse projections, the selected model life tables and age structures determine the number of persons

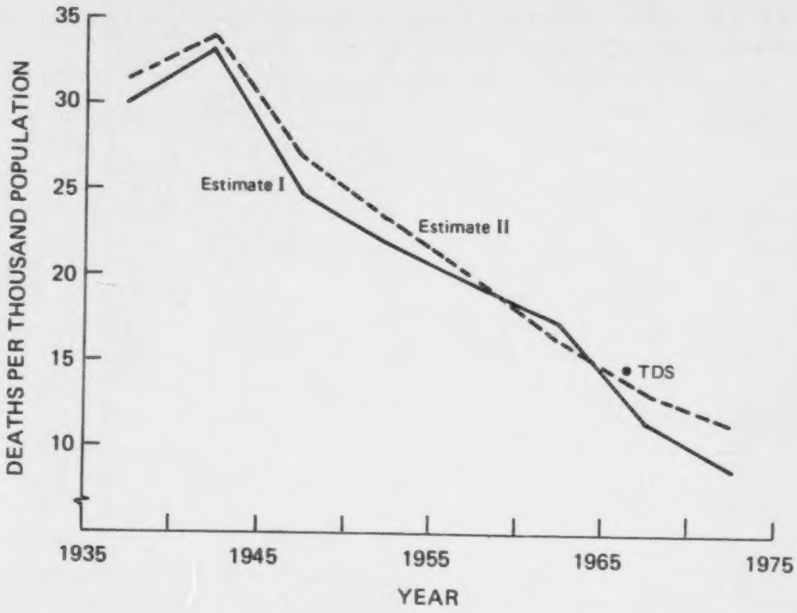


FIGURE 23 Alternative Estimates of the Crude Death Rate, 1935-75: Turkey

Source: Table 29.

removed from the population by death and hence are a factor in determining the rate of population increase, p (column 5). The age pattern of mortality involves most deaths at the very youngest and oldest ages, which are the locations in the age distribution most subject to errors of estimation. In addition, some error in the representation of Turkish conditions by the pattern of death rates in model life tables is to be expected at the extremities of age. This is not such a serious problem at young ages because reasonably strong estimates of infant and early childhood mortality are available (see Chapter 3), but adult mortality is not measured as accurately.

The level of Estimate II relative to Estimate I suggests that the errors in either or both series are systematic over time, because there is a more or less constant differential between the two. Whatever the source of the differences between Estimate I and II, the slope of the trend is very similar in both series. Thus, either estimate of trend would tell practically the same story. It is also reassuring to note that a wholly independent estimate of the death rate in 1966-67 by the Turkish Demographic Survey tends to confirm the level of Estimate II.

SUM OF COMPONENTS

Figure 5 in the Summary presents a convenient overall picture of the different components of population change and their sum, p, which is the rate of population increase. The two estimates of the death rate are averaged at each date for presentation in the upper panel. However, in order to show the official census estimates of the rate of population increase, an additional dashed curve of p is included in the lower panel. The general agreement of the two curves strengthens confidence in the estimated crude birth and death rates. Some error no doubt remains, particularly because estimates of international migration, which play a role in the indirect estimation procedures, are less strong than the other data.

Appendix A

Estimation of Fertility by Multiple Reverse Projection

Frederic C. Shorter

Reverse projection is known chiefly for its use in estimating past trends of fertility. Age structure is the crucial element of the census data from which inferences are drawn. Errors in the reporting of age are common in many countries, so use of census data for reverse projection requires methods that insulate the results from these age errors. Multiple reverse projection is such a method. It relies on reverse projections from a series of censuses arranged so that the effects of age reporting errors on estimates are systematically offset.

The method, and its application to the estimation of crude birth rates in Turkey, is explained in general terms in Chapter 2. The purpose of this appendix is to explain the data requirements of the method, its mathematical statement, and the results. One of the multiple reverse projections for Turkey is reproduced in detail below. This example illustrates how all components of population change--including fertility, mortality, and migration--are evaluated in a consistent manner over time.

DATA REQUIREMENTS

The minimum set of information needed for a reverse projection includes (1) a distribution of the population by age and sex and (2) assumptions about mortality over the period of the reverse projection. In a reverse projection, the number of births is reconstructed from information on the number of survivors in the current population distribution and the mortality to which they were subject in the past. Therefore, no fertility assumptions are necessary. Nevertheless, the results include numbers of births, crude birth rates, and general fertility rates.

The reverse projection is made by five-year age groups in steps of five years, going back in time as far as necessary. The minimum data may take the form of the following:

1. An age distribution for each sex in five-year age groups from age 0 to an open-ended interval 75+.
2. A set of life table survival rates for each sex for each five-year reverse projection period. These are normally selected from model life tables.

Optional data are the following:

3. For each sex separately, the proportion of the population aged 70+ that is aged 75+, based on data from actual censuses dated in multiples of five years prior to the starting date of the reverse projection. This information allows the distribution of population by age in the open interval, 75+, to be calculated using assumptions from the actual population rather than from the stationary population of the life table.
4. Net migration by five-year age groups for each sex for each five-year reverse-projection period. This information allows the effect of migration on the indirect estimates to be removed.
5. Age-specific and total fertility rates may also be calculated, if a standard age-specific fertility schedule is provided.

MATHEMATICAL STATEMENT

The basic element of a population projection is a group of persons whose common identification is their sex and period of birth. They form a birth cohort, which for convenience in calculations is defined as a five-year cohort. A reverse projection is made by "reverse surviving" each cohort separately back through time, in cycles of five years. Each cycle is a separate reverse projection providing the starting point for the next five years. The projection keeps track of each cohort separately as it is increased by reverse survival (deaths are restored to the population), by reversing in- and out-migrations, and removing cohorts from the population as the cohorts are carried back to birth. Cohorts are designated as follows for each five-year cycle:

Cohort index (c)	Age at Year -5	Age at year 0
0	Born	0-4
1	0-4	5-9
2	5-9	10-14
3	10-14	15-19
4	15-19	20-24
5	20-24	25-29
6	25-29	30-34
7	30-34	35-39
8	35-39	40-44
9	40-44	45-49
10	45-49	50-54
11	50-54	55-59
12	55-59	60-64
13	60-64	65-69
14	65-69	70-74
15	70-74	75-79
16	75+	80+

The reverse-survival equation, omitting migration for the moment, is as follows:

$$C^{-5}_{s,c} = C^{0}_{s,c}/S_{s,c} \quad (c = 0,16;\ \text{migration} = 0) \tag{1}$$

where C is the five-year birth cohort, s stands for sex (male or female), c stands for the cohort index number, and S is the five-year survival rate. The superscript, 0 or -5, refers to the date in years.

When the reverse-survival equation is applied to the youngest birth cohort, c=0, the result is a quantity of births, B, during the five-year period:

$$B_{s} = C^{-5}_{s,o} \tag{2}$$

At the upper end of the age distribution the two age groups 75-79 and 80+ are combined into 75+ in the initial data for year 0. In order to reverse-project this uppermost age group, the two cohorts that it contains (15 and 16) must be split out separately. The reverse-survival equation cannot be applied to cohorts 15 and 16 until this splitting has been performed.

In the absence of other information, the proportion of the life table population aged 75+ that is aged 75-79 is used as the basis for splitting:

$$C_{s,15} = [{}_5L_{75}/({}_5L_{75} + T_{80})] \cdot A \tag{3}$$

$$C^{o}_{s,16} = A - C^{o}_{s,15} \tag{4}$$

where ${}_5L_{75}$ and T_{80} are life table notation that refer respectively to person-years lived in the age interval 75-80 and from 80 years of age to the end of life. The notation A refers to the size of the given population that is aged 75+ at the base year of the projection (year 0).

The assumption of a stationary life table age distribution at the uppermost ages is usually incorrect in applied work, because mortality and fertility were neither equal nor constant in the past. Migration causes additional deviations from the stationary pattern. Nevertheless, for short reverse projections, such as five or ten years, an incorrect assumption about age structure at the highest ages will have a negligible effect on estimates of recent demographic rates (e.g., CBR and CDR). For longer reverse projections, however, the cumulative effect of error over a number of five-year cycles is a matter of concern.

A second approach to splitting the uppermost age group is to utilize independent information from a census at date -5 years concerning the actual distribution of population above age 70. Let p be the proportion of the population aged 70+ that is aged 75+ at date -5. The following four equations are solved for four unknowns to split out the two cohorts:

$$C^{-5}_{s,16} = p\,[C^{-5}_{s,15} + C^{-5}_{s,16}] \qquad \text{p is given} \tag{5}$$

$$A = C^{o}_{s,15} + C^{o}_{s,16} \qquad \text{A is given} \tag{6}$$

$$C^{-5}_{s,16} = C^{o}_{s,16}/S_{s,16} \qquad S_{s,16}\text{ is given} \tag{7}$$

$$C^{-5}_{s,15} = C^{o}_{s,15}/S_{s,15} \qquad S_{s,15}\text{ is given} \tag{8}$$

Four unknowns: $C^{-5}_{s,15}$; $C^{-5}_{s,16}$; $C^{o}_{s,15}$; $C^{o}_{s,16}$

An additional complexity is migration, which is included in the general formulation of the reverse projection. When migrations are distributed equally over the five-year period, a good approximation for the survival rate applicable to migrants is the following:

$$\frac{1+S_{s,c}}{2} \qquad \text{(for } c = 1,16\text{)}$$

For migrants in the youngest cohort, those who were born and who migrated during the interval, an approximation for the survival rate is the following (Shorter and Pasta, 1974:120-121):

$$.67 + .33\ S_{s,c}$$

To take migration into account equation (1) is replaced by two equations: one for the youngest cohorts (those born during the period) and a second for the remaining cohorts:

Youngest cohort:

$$C^{-5}_{s,o} = \frac{C^{o}_{s,o} - M_{s,o}[.67 + .33S_{s,o}]}{S_{s,o}} \qquad (9)$$

Remaining cohorts:

$$C^{-5}_{s,c} = \frac{C^{o}_{s,c} - M_{s,c}\ (1+S_{s,c})/2}{S_{s,c}} \qquad [c = 1,16] \qquad (10)$$

where $M_{s,c}$ refers to the migration information by sex and cohort. If the age group 75+ is split according to the procedures of equations (5) through (8), the effect of migration is included by substituting equation (10) for equations (7) and (8).

Births are produced separately by sex in the reverse projection. The sex ratio of births is a consequence of the relative sizes of the 0-4 age groups and the assumed mortality rates by sex. The proportion of births that are girls, g, where f and m refer to females and males respectively, is

$$g = C^{-5}_{f,c}/(C_{f,o} = C^{-5}_{m,o}) \qquad (11)$$

Various fertility indices are calculated from the resulting projection. Total births are the sum of births by sex given by equation (2). The crude birth rate is total births divided by the geometric mean of the total population at dates 0 and -5. The general fertility rate is total births divided by the geometric mean of female population aged 15 to 44 at dates 0 and -5.

Age-specific fertility rates are calculated by introducing independent information about the distribution of childbearing by age of woman. These data are a model age-specific fertility schedule or a representative schedule from the population itself, expressed as rates or as a percentage distribution across the age range of 15-49. The schedule is denoted by F^*_i where the index, i, refers to the 7 five-year age groups from 15 to 49. The shape of the schedule, not its level, is used to distribute births by age of woman and thus to estimate the age-specific fertility rates.

A preliminary step is to calculate the geometric mean of women in each age group from 15 to 49, $\overline{W}_i$. A trial number of births, B*, is then calculated as follows:

$$B^* = 5 \cdot \sum_{i=1}^{7} (F^*_i \cdot \overline{W}_i) \qquad (12)$$

Since the age-specific fertility rates, F^*_i, are not the actual ones, they must be revised by a multiplier, k, which brings B* into agreement with B.

$$k = B/B^* \qquad (13)$$

$$F_i = kF^*_i \quad [i = 1,7] \qquad (14)$$

The total fertility rate, T, is the sum of the age-specific rates:

$$T = 5 \cdot \sum_{i=1}^{7} F_i$$

MULTIPLE REVERSE PROJECTIONS FOR TURKEY

For the period from 1935 to 1975, there are nine censuses of which the last eight (1940 to 1975) provide the initial age data by sex for each reverse projection. The survival rates for 8 five-year periods (1935 to 1975) were taken from split-level "East" model life tables (Table 28). All the options for finer calculation and for the production of total fertility rates were used. The proportion of the population aged 70+ that was aged 75+ in each prior census (1935 to 1970) was obtained from the census age distributions (Table 1). Migration estimates provide assumptions for each five-year period from 1935 to 1975 (Appendix Table D-2). Standard schedules of age-specific fertility are also used (see section on standard fertility schedules).

The actual computations were made with a computer package available from the Population Council (Shorter and Pasta, 1974; Shorter, 1980). An example of the results for one reverse projection is shown in Table A-1.

The present study utilized multiple reverse projections based first upon age distributions as reported (Table 1) and then as adjusted for age misreporting (Appendix Table C-3). Standard fertility schedules were used reflecting both the "early 1960s" and the changing pattern assumptions.

The method works best when censuses are available at five-year intervals, but it can also be used with censuses spaced ten years apart. Using only the ten-year censuses for Turkey from 1945 to 1975, another series of estimates was produced. Both series are shown in Figure A-1. Since the reverse projections were made in steps of five years, estimates of the birth rate were obtained every five years and should be averaged over ten-year periods to reflect the lower degree of precision in the basic data.

```
   20            512.5       794.8      1059.2      1289.6      1236.5      1217.7      1503.5      1833.1
   25            751.0       488.9       770.1      1042.2      1273.7      1174.5      1166.6      1452.3
   30            601.5       713.5       472.8       757.1      1029.0      1211.1      1097.1      1092.6
   35            577.2       566.4       685.3       463.6       745.6       990.7      1143.6      1034.3
   40            500.8       535.6       538.6       665.0       454.1       720.6       942.1      1095.2
   45            358.4       456.3       502.0       517.1       642.9       436.8       685.5       903.6
   50            288.9       318.9       419.0       472.8       492.0       611.9       414.4       654.5
   55            252.1       248.2       283.9       383.5       437.7       457.3       571.8       388.8
   60            216.2       204.9       210.7       249.1       341.2       391.7       412.1       517.5
   65            196.5       160.7       161.4       173.0       208.5       288.2       333.8       353.4
   70            143.3       126.8       112.3       119.0       131.0       160.2       224.2       261.9
   75+           151.9       123.6       118.1       116.4       124.8       139.3       167.9       226.2
   TOT          9324.6      9826.3     10820.3     12294.3     14274.2     16432.3     18502.7     20417.2

   GRAND
   TOTAL       18778.7     19623.7     21494.2     24287.1     28052.4     32221.5     36363.2     40197.7

                                   MIDPERIOD INDICES FOR FIVE-YEAR TIME PERIODS
POPULATION SIZE            19196.5     20537.6     22848.0     26101.9     30064.8     34229.8     38232.4
YEARLY BIRTHS                827.4       924.3      1057.2      1250.6      1382.2      1368.8      1263.0
YEARLY DEATHS                663.1       557.1       526.7       524.4       511.0       471.3       421.1
NET YEARLY MIGRANTS            4.7         6.9        28.1        26.9       -37.4       -69.2       -75.0

                                       YEARLY RATES PER THOUSAND POPULATION
GFR=BIRTHS/FEM(15-44)        221.3       223.0       222.9       235.3       229.8       197.1       158.5

BIRTH RATE                    43.1        45.0        46.3        47.9        46.0        40.0        33.0
DEATH RATE                    34.5        27.1        23.1        20.1        17.0        13.8        11.0
NATURAL INCREASE               8.6        17.9        23.2        27.8        29.0        26.2        22.0
NET MIGRATION                  0.2         0.3         1.2         1.0        -1.2        -2.0        -2.0
POP INCREASE                   8.8        18.2        24.4        28.9        27.7        24.2        20.1
```

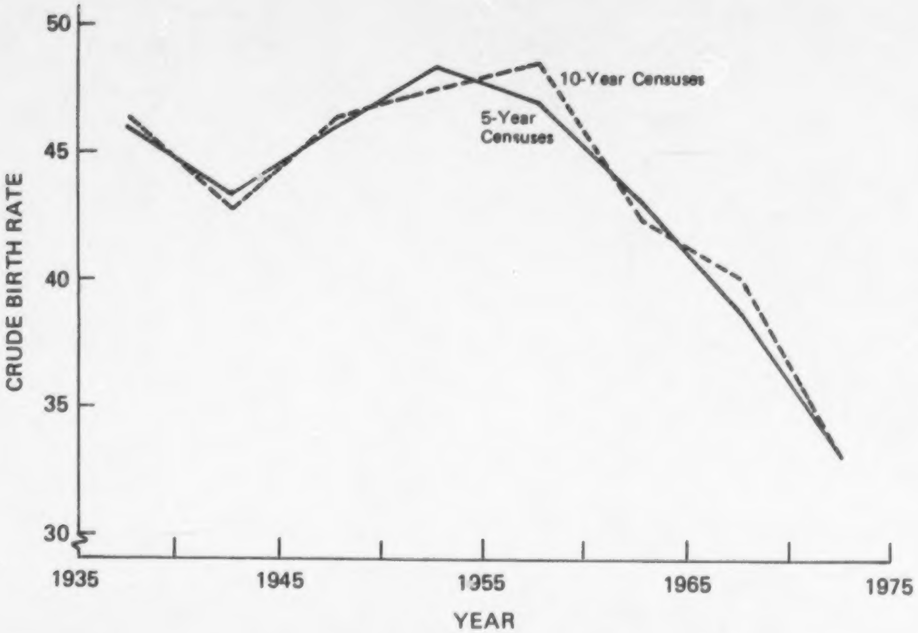


FIGURE A-1 Comparison of Estimates of CBR from Censuses Spaced Five and Ten Years Apart: Turkey (National, Reported Age Distributions)

Appendix B
Estimation of Trends in Infant and Early Childhood Mortality from Birth-Survival Histories
Miroslav Macura

This appendix describes a method for estimating time trends of infant and early childhood mortality for both sexes from birth-survival histories collected in a single sample survey. The method was developed expressly to estimate trends in Turkey from the birth-survival histories recorded in the 1968 Hacettepe survey. It was first employed in 1975 to obtain estimates for Turkey and her regional and urban-rural subpopulations (Macura, 1975a and 1975b). In the present study, the method was used to produce trend estimates for the six divisions of the country (Table 20).

DATA REQUIREMENTS

Application of the method entails the use of data routinely collected in birth-survival histories. The data refer to each live-born child and include: year of birth, the child's survival status at the time of survey, and the year of death if the child died before the survey year. The information is used to tabulate separately live-born and deceased children of both sexes by calendar year of birth. Among the former, only children born before the survey year are included. Among the latter, only those born and deceased before the year are covered. The tabulations are used to divide the numbers of deceased children by the corresponding numbers of live-born children by year of birth. The results are reported proportions dead prior to the survey year in single-year birth cohorts of children. The cohort proportions dead are used to estimate the trend of infant and early childhood mortality by the present method.

When estimates are sought for divisions of the country, as in the present study, women are classified by residence at the time of survey. The proportions dead obtained then pertain to selected divisions, subject to a number of reservations about the allocation of women's births to divisions different from present residence. Those are discussed in detail in Chapter 3.

APPLICATION OF THE METHOD

The method is described in two sections. The first explains a version of the method applicable to error-free data. In the second section, the version is extended to cope with certain imprecisions in data that normally arise in applying the method.

Estimation from Accurate Data

Let the year immediately prior to the survey year be denoted as t=0 and let time be measured in terms of calendar years, taking t=0 as the origin. Let d_a stand for the proportion dead at the end of the year t=0 in a cohort aged a years last birthday at this date. Let L_x be the life table number of person-years lived between exact years of age x and x+1. Now, there is an equation showing the relationship that exists between a cohort proportion dead and the cohort's probabilities of surviving through consecutive calendar years between birth and the end of t=0. If the life table radix, ℓ_0, is set equal to 1 and if an equation is written for each cohort, starting with the cohort aged 0 last birthday at the end of the year t=0, the following system of equations is obtained:

$$1 - (L_0)_0 = d_0$$

$$1 - (L_0)_{-1} \cdot (L_1/L_0)_0 = d_1$$

$$1 - (L_0)_{-2} \cdot (L_1/L_0)_{-1} \cdot (L_2/L_1)_0 = d_2$$

where subscripts of the survival ratios denote calendar years.

When information on d_a (for a=0, 1, 2, ...) is available from the birth-survival histories, the above equations make it possible to estimate the infant mortality rate, q(1), for each t (t=0, -1, -2,...) by utilizing Coale-Demeny model life tables (Coale and Demeny, 1966). The estimation procedure reduces to finding a model life table for each t, as follows.

First, a table for t=0 is located. It is the one that embodies the L_0 that satisfies the first equation. The table is found by interpolating linearly between both-sexes model life tables at integer levels of mortality of the selected Coale-Demeny family. It is then used to compute the survival ratios to which cohorts born before t=0 are exposed to in t=0: $(L_1/L_0)_0$, $(L_2/L_1)_0$,...

Next, a table for t=-1 is located. Given $(L_1/L_0)_0$, it embodies the L_0 for t=-1 that satisfies the second equation. The table is used to compute survival ratios to which cohorts born prior to t=-1 are exposed to in t=-1: $(L_1/L_0)_{-1}$, $(L_2/L_1)_{-1}$,...

Then, given $(L_1/L_0)_{-1}$ and $(L_2/L_1)_0$, the table for t=-2 which embodies the L_0 that satisfies the third equation is located. Further computations proceed in the same fashion.

Once the model tables for individual calendar years are located, the trend estimate is reached simply by associating the q(1)'s embodied in the tables with respective calendar years.

Estimation from Defective Data

Unless mortality rises strongly over time, the cohort proportions dead should increase as the cohort year of birth moves backward from t=0. When there are short-run fluctuations in mortality, the time schedule of proportions zigzags accordingly. Whenever the information used is defective, however, the schedules zigzag much more than could be possibly explained by the short-run fluctuations. Under most circumstances these excessive variations could plausibly be attributed to a more or less random misreporting of the year of birth and probably to sampling variance too. Both the misreporting and the sampling variance appear to affect the proportions of the cohorts born at earlier dates (say 20 to 30 years prior to t=0) more than those of cohorts born closer to the survey.

If the method is applied to proportions that are defective due to sampling variance and random misreporting, estimates of infant mortality rates referring to most of the years are biased; some are biased upward, the others downward. As a rule, estimates referring to years in which cohorts with unduly high proportions dead were born are upwardly biased and vice versa. Fortunately, it is largely possible to remove the bias arising from the data errors by utilizing smoothing, which is described next.

The proportions dead are first plotted against time (year of birth) and then approximated by a smooth, free-hand-drawn time schedule of proportions dead. Then, values of the proportions are read from the smooth schedule and converted into a trend estimate, as if the data utilized were error-free. Next, the time period spanned by the schedule is split into two intervals of approximately equal length and a ratio is calculated for each interval. The denominator of the ratio for the given time interval is the reported number of deaths that occurred before the survey year in cohorts born within the interval. The numerator is the number of deaths that would have occurred before the survey year if the cohorts born within the interval had been exposed to mortality conditions consistent with the smooth proportions.

To show how a ratio for a particular interval is computed, let S_a and D_a be, respectively, reported numbers of surviving and dying children before the end of t=0 in a cohort age a. Let d'_a be a "smooth" proportion dead of the same cohort and D'_a be the number of deaths consistent with d'_a, where D'_a is calculated as $(d'_a)(S_a)/(1-d'_a)$. The formula for calculating D'_a is derived from the definition of the smooth proportion dead: $d'_a = D'_a/(D'_a+S_a)$. Now the ratio of the time interval $-a_1$ to $-a_2$, a_2 a_1, is computed as:

$$\sum_{a=a_1}^{a_2} D'_a \div \sum_{a=a_1}^{a_2} D_a$$

where a is an age variable and a_1 and a_2 are years of age at the end of t=0 of cohorts born in the latest and the earliest years of the interval, respectively.

When the smooth schedule is a poor approximation of the observed proportions, the segment of the trend that refers to a few years immediately prior to t=0 is sawtoothed or kinked and/or one or both ratios differ markedly from unity. The ratio for a particular interval that exceeds (or falls short of) unity results from smooth proportions which on the average exceed (or fall short of) the corresponding observed proportions. Normally, it is necessary to draw a few smooth schedules before the one that approximates observed proportions closely is reached. The ratios implied by this schedule are close to unity and the trend obtained is smooth throughout. The trend is an estimate of the past time path of infant and early childhood mortality.

Use of Aggregated Cohorts

It is possible to save the time and effort entailed in estimating the trends if proportions of aggregated--say, two-year--rather than single-year birth cohorts are used. The use of three- or five-year cohort proportions is possible too. However, in order to control for imprecisions arising from the aggregation itself, estimation for Turkey was based on the proportions of the two-year cohorts.

BIASES ARISING FROM ERRORS IN DATA AND ASSUMPTIONS

The estimates of trends in infant and early childhood mortality based on birth-survival histories may suffer from several errors in data and assumptions. Concerning data inaccuracies, the trend estimates could be biased due to sampling variance and random misreporting of the year of birth, the two causes of data errors discussed earlier. They could also be defective as a result of selective omission of deceased children and misreporting that exaggerates time elapsed since birth.

To offset adverse effects of the sampling variance and the random misreporting, smoothing was incorporated into the estimation. It is fairly likely that under most circumstances smoothing keeps biases associated with these data problems under control. Under special conditions, however, smoothing is not equally useful; for example, when the number of children included in birth-survival histories is very limited and/or when year-of-birth misreporting, although largely random, is particularly pronounced. Under such circumstances, the trend obtained may depend to a considerable degree on the choice of the intervals for which ratios are computed.

Errors in data associated with selective omission of deceased children and year-of-birth misreporting that exaggerates time elapsed since birth affect the trend estimates fully. To the extent these two problems exist, they probably affect more strongly information pertaining to children born longer ago. Hence, it is quite likely that these two causes of data errors, when present, result in proportions dead that rise less steeply than in reality with the cohort year of birth, as it moves backward from the survey year. When the proportions dead are defective in the way just described, infant mortality rates referring to earlier years are downwardly biased and consequently the overall rate of mortality decline is underestimated.

The trend estimation is based on a few implicit assumptions. Whenever the method is applied, two assumptions are used. The first maintains that the age pattern of mortality between ages 0 and 25 to 30 embodied in the Coale-Demeny model family used closely approximates the pattern prevailing in the population for which the estimate is sought. The second assumption postulates no association between the survival of mothers and the mortality of their children.

When the estimation is performed for regional and urban-rural divisions of the national population, two additional assumptions are made. According to the first, effects on the trend estimates arising from transfers of infant and childhood mortality experience across divisional boundaries are minor; the transfers are assumed to be the consequence of pre-survey migration of women. According to the second, transfers of the mortality experience across urban-rural boundaries, which arise from reclassification of communities as their size changes, have negligible effects on trend estimates.

Nonfulfillment of the assumptions leads to biases in the estimates. Thus, when the model and real age patterns of mortality differ, the trend estimate is erroneous. Likewise, when the assumptions on approximate neutrality of transfers of infant and childhood mortality experience are violated, the divisional estimates are bound to be biased. These qualifications of the estimates are discussed in greater detail in Chapter 3 and adjustments are introduced to take the more important biases into account.

Appendix C
Adjustment of the National Censuses for Age Misreporting

Age misreporting is a common defect of censuses, and a variety of methods have been developed to deal with the problem. A procedure suitable for the Turkish censuses was developed by Demeny and Shorter (1968). In recent years, refinements of the method have appeared in the literature, and they are useful for interpreting the age misreporting pattern.

Misreporting consists of raising or lowering one's age, which affects the standard census age distribution by transferring some persons across the boundaries of standard five-year age groups. Das Gupta (1975) applied a model of these transfers to Turkish females in the 1955 and 1960 censuses, and showed that misreporting for females typically consists of upward transfer (Table C-1). Above age 40, age heaping (see glossary) dominates, but it does not stop the persistent upward "slide" that starts from the very youngest age group. The overall pattern is the so-called Asia-Africa one described in Manual IV (United Nations, 1967); it was identified in Turkey by Demeny and Shorter and confirmed by Das Gupta (1975) and Ntozi (1978), each using somewhat different methods.

A fine example of Turkish age exaggeration comes from the 1935 census, which tabulated persons aged 100 years old and over by province. In that census, 2,256 males and 3,985 females claimed to be centenarians. The centenarian rates were approximately 1,000 per million inhabitants in Eastern Turkey and 200 in Western Turkey. An old but reasonably accurate Japanese life table with a life expectation of 42 years for males (similar to that of Turkey in 1935) shows only 2 centenarians per million inhabitants.

TABLE C-1 Proportions of "True" Population of Females in 1955 Transferred Upward or Downward from Five-Year Age Groups by Misreporting: Turkey

Age Group	Population[a] (thousands) Enumerated	"True"	Direction of Transfer	Population Transfers Up	Down	Proportions of "True" Population Transferred Up	Down
0-4	1,889	1,970.7	up	81.7	--	.041	--
5-9	1,570	1,531.7	up	43.4	--	.028	--
10-14	1,097	1,113.4	up	59.8	--	.054	--
15-19	1,094	1,167.0	up	32.8	--	.114	--
20-24	1,117	1,131.2	up	47.0	--	.130	--
25-29	1,027	954.1	up	74.1	--	.078	--
30-34	735.1	689.1	up	28.1	--	.041	--
35-39	528.5	515.5	up	15.1	--	.029	--
40-44	624.7	587.3	neither	--	--	--	--
45-49	475.6	544.6	both	46.7	22.3	.086	.041
50-54	531.0	479.4	neither	--	--	--	--
55-59	310.4	383.5	both	68.2	4.9	.178	.013
60-64	389.3	301.1	neither	--	--	--	--
65-69	173.7	216.2	both	22.5	20.0	.104	.093
70-74	172.1	155.2	up	5.6	--	.036	--
75 +	159.3	153.0	neither	--	--	--	--
Total	11,893	11,893					

[a] The population of 1955 is adjusted relative to 1960 for the effect of international migration as required by the correction procedure.

Source: Computed from Das Gupta (1975).

The elegant representation of misreporting achieved by the Das Gupta refinement of the Demeny-Shorter procedure requires elaborate computer work; a different program is required for each sex and every pair of censuses. Comparing Das Gupta's results with those of Demeny-Shorter's original, rather simple method shows that there is little practical difference (Table C-2). Therefore, the simpler approach is preferable for practical applications.

PATTERNS OF AGE ERROR BY SEX

The pattern of age error for Turkish females and males differs markedly, though not in the youngest two age groups. The amount of excess or deficient reporting due to age transfers is shown in Figure C-1 for each age

TABLE C-2 Comparison of Demeny-Shorter (D-S) and P. Das Gupta (PDG) "Corrections" of Age Distributions for Misstatement of Age, Females, 1955 and 1960: Turkey

1960 Census (in thousands)				Size of "Correction" (percents)			
		"Corrected"		1960		1955[a]	
Age Group	Census as Enumerated	D-S	PDG	D-S	PDG	D-S	PDG
0-4	2,079.0	2,159.0	2,169.0	4	4	4	4
5-9	1,928.0	1,892.0	1,892.0	-2	-2	-2	-2
10-14	1,489.0	1,512.0	1,517.0	2	2	1	2
15-19	1,059.0	1,100.0	1,103.0	4	4	7	5
20-24	1,128.0	1,128.0	1,152.0	0	2	1	0
25-29	1,177.0	1,108.0	1,114.0	-6	-5	-7	-6
30-34	985.8	955.7	937.9	-3	-5	-6	-4
35-39	693.8	694.8	676.2	0	-3	-2	0
40-44	548.4	518.9	504.3	-5	-8	-6	-6
45-49	500.0	570.8	572.1	14	14	15	15
50-54	581.2	530.9	526.1	-9	-9	-10	-9
55-59	369.4	450.9	456.5	22	24	24	24
60-64	461.4	359.9	355.6	-22	-23	-23	-23
65-69	213.8	258.5	265.9	21	24	24	24
70-74	195.7	175.7	174.8	-10	-11	-10	-11
75+	182.1	177.3	175.2	-3	-4	-4	-5
Total	13,591	13,591	13,591	0	0	0	0

Note: These "corrections" were in both instances based on the use of "South" model life tables. Subsequent research has shown that split-level "East" models are the best fit to Turkish mortality. Adjustments of age distributions by the panel are based on the "East" models.

[a] Enumerated and corrected data not shown in this table.

Sources: Demeny and Shorter (1968:33, 53-54); Das Gupta (1975:311).

group by selecting a reasonably representative pair of censuses (1955 and 1960) to show the differences by sex. Females are underreported in the range of 10 to 25 years of age and overreported from 25 to 35. This particular vacating of one age range and overreporting of another is probably due to claims of a higher-than-true age immediately after marriage or childbearing. Note that the quantitative amounts of error do not necessarily imply that very large numbers of people misreport age.

Males on the other hand, are attributed ages on a different social basis than females, with the result that they are overreported in the 10-20 age range and underreported from 20 to 30. Some persons apparently claim, or are judged by enumerators, to be below the age

TABLE A-1 Sample Reverse Projection (in thousands) from 1975 (1935-40 not shown): Turkey

FEMALES

AGE	1940	1945	1950	1955	1960	1965	1970	1975
0	1450.9	1318.9	1593.3	1885.7	2324.8	2640.3	2767.7	2652.5
5	1239.2	1275.6	1197.4	1475.9	1771.7	2198.7	2518.3	2665.9
10	970.4	1195.9	1247.8	1188.5	1469.7	1757.8	2177.8	2495.7
15	779.7	942.0	1173.5	1238.2	1183.6	1457.6	1742.3	2160.2
20	493.0	749.3	918.3	1159.5	1227.6	1164.0	1433.3	1713.9
25	750.2	469.3	725.7	904.7	1146.5	1203.0	1132.1	1394.4
30	563.9	708.5	452.6	712.8	893.1	1124.3	1172.4	1098.9
35	557.3	529.6	679.6	443.4	701.5	875.3	1095.7	1141.3
40	490.9	520.6	506.0	661.1	435.2	685.9	850.1	1065.8
45	445.6	455.9	494.6	490.1	643.2	423.4	665.3	826.0
50	409.0	407.2	427.4	473.2	472.4	619.9	409.5	645.3
55	369.9	360.4	371.4	400.0	447.3	447.9	591.2	392.3
60	320.9	306.0	313.5	334.7	365.9	411.6	415.8	551.8
65	268.8	239.8	246.3	264.9	289.0	319.4	363.8	370.4
70	184.2	172.6	170.9	187.1	207.4	230.2	258.8	298.0
75+	160.2	145.6	155.6	173.2	199.4	230.1	266.3	308.1
TOT	9454.1	9797.3	10673.9	11992.8	13778.2	15789.3	17860.5	19780.5

MALES

AGE	1940	1945	1950	1955	1960	1965	1970	1975
0	1460.9	1391.4	1665.8	2007.1	2492.2	2885.5	2905.3	2765.2
5	1371.7	1280.5	1258.8	1538.6	1882.5	2352.0	2749.1	2795.7
10	1115.3	1328.7	1255.9	1252.0	1534.8	1870.7	2331.3	2728.7
15	826.3	1087.1	1306.5	1248.2	1247.8	1524.1	1854.4	2314.2

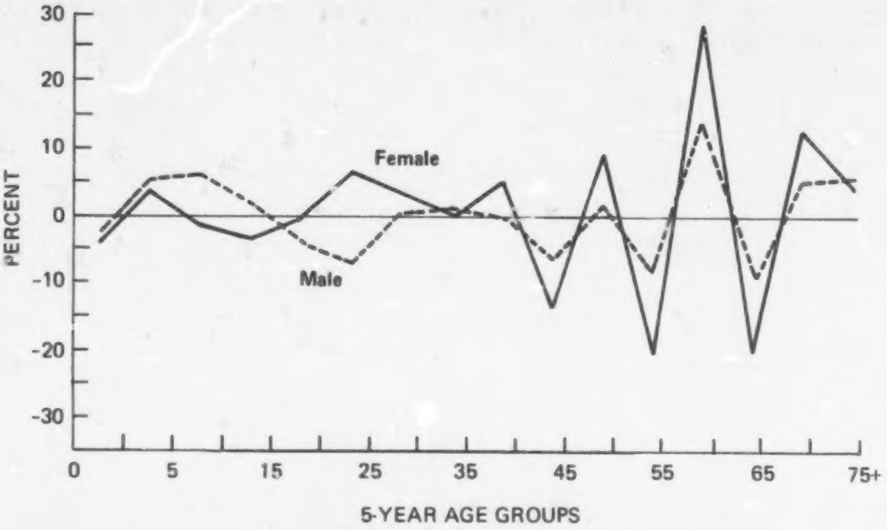


FIGURE C-1 Age Errors by Sex: Difference Between Enumerated and Corrected Population by Five-Year Age Groups: Turkey (excess as percent of corrected)

Source: For 1955-60 pair of census, see Tables 1 and C-3.

of military service (about age 20), or marriage (mid-20s) until these events actually occur. This causes many males to be reported at a lower age when they are actually in the 20-30 range, thus depleting the number reported in the upper range. At the upper end of the 20-30 range, some men may well be reported at ages above 30 if they are married. Males typically marry in their mid- and late 20s and thereafter become known as 30 or above even if they are not in fact that old.

Age heaping on tens above age 40 is stronger for females than males, suggesting that female age reporting is generally less accurate than male reporting.

AGE CORRECTIONS FOR 1935-75

The Demeny-Shorter method was applied to all pairs of censuses from 1935-40 to 1970-75. The method works well for the period from 1935 to 1960. Thereafter, out-migration was substantial and age errors in the migration data cause errors in the estimated correction factors themselves. The pattern of age errors detected for each sex is stable over the 1935-60 period, with a slight trend toward reduced magnitude in general. The corrections for 1935 to 1960 were carried out, therefore, by fitting a linear trend to the age correction factors for each age group between 1935-40 and 1955-60. The factors were then held constant after 1960. The corrected national age distributions are shown in Table C-3 and Figure C-2.

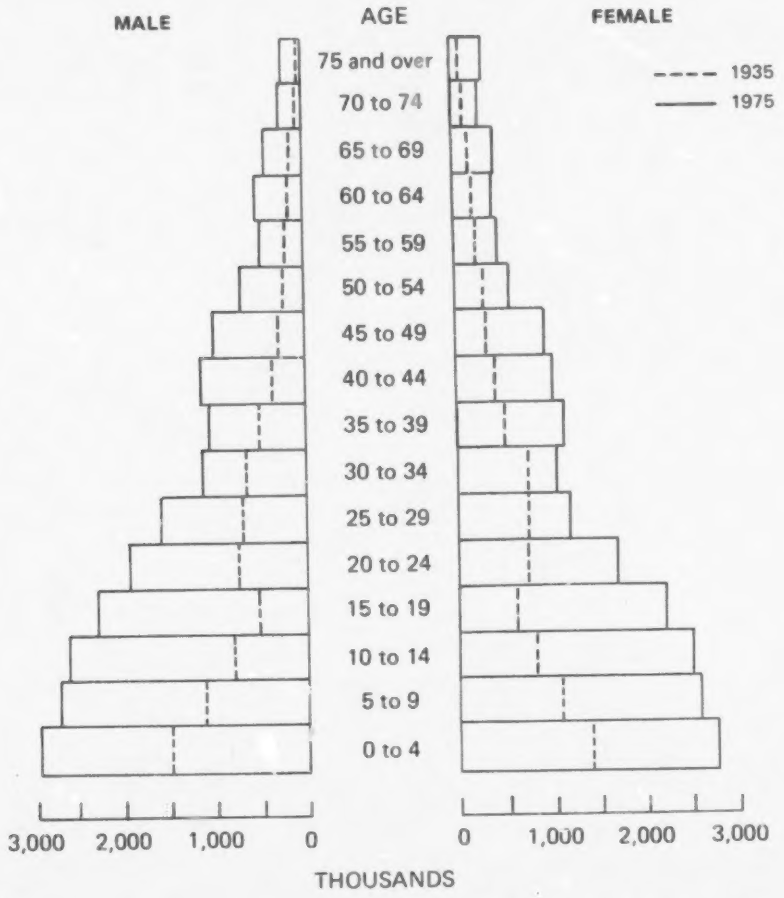


FIGURE C-2 Population by Age and Sex Corrected for Age Misreporting, 1935 and 1975: Turkey

Source: Table C-3.

TABLE C-3 Population (in thousands) by Age and Sex, Corrected for Age Misreporting, 1935-75: Turkey

Age	1935[a]	1940	1945	1950	1955	1960	1965	1970	1975[b]
Males									
0-4	1,486.0	1,427.0	1,331.0	1,638.0	2,053.0	2,270.5	2,462.5	2,775.4	2,882.0
5-9	1,122.0	1,312.0	1,261.0	1,258.0	1,587.0	1,987.0	2,323.0	2,505.0	2,681.1
10-14	802.1	1,115.0	1,210.0	1,201.0	1,221.0	1,601.1	1,958.7	2,243.8	2,589.5
15-19	541.5	798.9	1,018.0	1,235.0	1,217.0	1,228.3	1,527.6	1,896.9	2,279.6
20-24	767.2	533.4	809.1	1,017.0	1,245.0	1,221.6	1,262.5	1,556.0	1,905.1
25-29	691.3	748.3	528.2	785.9	1,030.0	1,238.3	1,134.8	1,188.9	1,557.4
30-34	647.4	663.6	770.6	538.5	751.7	1,011.6	1,126.1	1,005.5	1,077.4
35-39	519.4	614.1	624.2	694.1	514.9	733.0	980.6	1,095.6	1,013.7
40-44	348.0	489.0	562.6	562.3	668.5	501.3	701.9	915.6	1,087.6
45-49	263.2	324.6	430.5	533.2	558.5	650.6	477.4	689.1	965.3
50-54	222.7	242.3	277.4	381.1	494.2	538.5	604.2	450.0	644.1
55-59	186.7	197.7	192.1	237.5	358.9	463.3	492.9	543.7	425.1
60-64	146.0	158.9	169.9	169.3	211.4	326.1	402.2	422.2	458.4
65-69	117.3	114.5	111.9	127.8	139.1	181.6	282.8	351.8	386.4
70-74	89.7	80.5	77.3	74.0	93.6	107.8	138.6	209.7	248.6
75+	79.5	79.7	71.7	75.4	90.3	103.3	121.2	157.9	215.8
Subtotal	8,030	8,899	9,447	10,527	12,233	14,164	15,997	18,007	20,417

Appendix D
International Migration

Data on international migration are required for several of the procedures used in this report: estimating crude birth rates by multiple reverse projections (Chapter 2), estimating mortality above age 5 by forward projection (Chapter 3); and adjusting the censuses for age misreporting (Appendix C). Available data were used, therefore, to establish estimates of the net balance of migration and its distribution by sex and age.

MIGRATION VOLUME

The censuses of West Germany enumerate population by national origin. These censuses, reports by the Labor Bureau in Turkey, and special studies of the State Planning Organization based on Turkish consular surveys and other sources, were used to formulate the migration estimates from 1960 to 1975. For 1935 to 1960, volume estimates by Turkish scholars are available (Geray, 1962; Turkay, 1962).

Censuses of destination countries such as West Germany are particularly useful in making migration estimates, because they keep track of the stock of Turks living abroad. Two-way circulation with the home country shows up as changes in this stock after allowance for natural increase. To illustrate how this estimation procedure works, the use of the West German censuses to estimate the net flow during 1970-75 is explained below.

The Turkish population in West Germany increased from 429.4 thousand in May 1970 to 1,079.3 thousand at the end of September 1976. (Data for the exact five-year period, 1970-75, are not available.) This change amounts to an annual rate of increase of 14.5 percent. Births to

Turkish parents living in Germany (both parents Turks) were 161.4 thousand, implying a crude birth rate among the migrants of 43 per thousand. Since the death rate presumably is low (perhaps about 8), natural increase may be assumed to be 3.5 percent. A population increase of 11 percent (14.5 percent less 3.5 percent) due to migration implies the volume of Turkish migration to Germany during the five years from October 1970 to October 1975. To calculate the growth of the migrant population over the five-year period, the following equation is used:

$$P_1 = P_o(e^{rt})$$

where P_1 is the population to be estimated, P_o is the original population, r is the yearly rate of growth, and t is time elapsed (years) between the dates of P_o and P_1.

Size of Migrant Stock	Thousands
Oct. 1970: 429.4 $e^{(.145)(.5)}$	461.7
Oct. 1975: 429.4 $e^{(.145)(5.5)}$	953.3
Change in size over five years	+491.6
Allocate 11.0/14.5 to migration	372.9
Balance due to natural increase	118.7

A second source of information is annual data from West Germany on migrant movements themselves. These data, shown below, justify a five-year net migration estimate of 300 to 400 thousand:

Year	Net Migrants (thousands)
1971	+126.4
1972	not available
1973	+162.8
1974	+ 50.0
1975	- 49.9

An upward bias may exist in these particular data because they are described as including "short-term" in-migrants. The out-migrant data, on the other hand, are deletions from local population registers where Turks have registered their residence.

Allowing a margin for net migration to other countries, and for demographic growth of the net migrant flow after arrival abroad, the demographic effect on the Turkish population in Turkey for 1970-75 is estimated at a loss of 400 thousand persons. This estimate, taken together with estimates from other sources for other dates, provides the series shown in the last column of Table D-1.

The distribution of migrants by sex and age for the years since 1960 is found in a sample survey by Abadan (1964), the censuses of the Federal Republic of Germany, and Turkish consular reports collected and analyzed by

TABLE D-1 Demographic Effect of International Migration on National Population Size, 1935-75: Turkey

Intercensal Period of Migration	Change in National Population (thousands)		
	Males	Females	Total
1935-40	67.3	67.5	134.8
1940-45	12.6	12.4	25.0
1945-50	18.6	18.4	37.0
1950-55	77.8	75.2	153.0
1955-60	73.5	70.5	144.0
1960-65	-161.8	-37.8	-199.6
1965-70	-256.0	-114.6	-370.6
1970-75	-248.0	-152.0	-400.0

Note: The demographic effect of migration at the end of a five-year period of migration differs from the actual number who migrate during the period, because the migrant population continues to change with natural increase between the dates of migration and the second census date of the period.

Sources: Estimates for 1935-60 are based on Geray (1962) and Turkay (1962). For 1960-70, estimates are from the State Planning Organization. The 1970-75 estimate is from an analysis of the census and vital statistics of the Federal Republic of Germany and from information on the pattern of destinations in prior years.

the State Planning Organization. For periods prior to 1960, international migration was chiefly whole families, because it was relocation of population. A reasonable assumption is that migration up to 1960 had the same sex and age distribution as the Turkish population.

The estimates that provide the assumptions for the multiple reverse projections of Chapter 2 are shown in Tables D-2 and D-3. Adjustments for age misreporting and the estimation of mortality above age 5 make use of the material in Table D-1.

The migration data are useful as intermediate estimates for other calculations, even though they are subject to considerable possibilities for error. The methods used to estimate fertility and mortality were handled with an awareness of the extent of error introduced by migration error. Judgment based on general knowledge of the Turkish situation has been used to accept some implications and not others.

TABLE D-2 Average Yearly International Migration for Intercensal Periods, 1935-75: Turkey

	Net Migration (thousands)		
Period	Males	Females	Total
1935-40	12.8	12.9	25.7
1940-45	2.4	2.3	4.7
1945-50	3.5	3.4	6.9
1950-55	14.3	13.8	28.1
1955-60	13.7	13.2	26.9
1960-65	-30.3	- 7.1	-37.4
1965-70	-47.8	-21.4	-69.2
1970-75	-46.5	-28.5	-75.0

TABLE D-3 Distribution of Net International Migration by Age, for Each Sex, 1960-75: Turkey

Age Group	1960-65 Males	1960-65 Females	1965-75 Males	1965-75 Females
0-4	5.2	21.4	4.4	9.5
5-9	2.2	9.0	4.6	9.4
10-14	-1.2	-4.5	3.9	7.6
15-19	1.1	13.0	0.5	3.3
20-24	20.5	30.2	4.8	20.6
25-29	40.2	21.4	26.8	17.7
30-34	19.4	9.0	26.8	13.7
35-39	9.1	4.2	16.0	10.6
40-44	2.9	1.1	9.7	8.4
45-49	1.6	0.8	3.5	1.2
50-54	-0.4	-1.3	-0.3	-0.5
55-59	-0.2	-1.1	-0.2	-0.4
60-64	-0.2	-1.3	-0.2	-0.4
65-69	-0.1	-0.8	-0.1	-0.3
70-74	-0.0	-0.5	-0.1	-0.2
75+	-0.0	-0.5	-0.0	-0.2
Total	100.0	100.0	100.0	100.0

Appendix E
Population by Six Divisions by Age and Sex, 1945-70

TABLE E-1 Population of Six Divisions by Age and Sex as Reported in the Censuses, 1945-70: Turkey[a]

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part A	1945						
Males							
0-4	36,917	41,900	78,949	395,816	416,395	318,378	1,288,355
5-9	38,388	44,888	85,383	424,906	437,495	319,078	1,350,138
10-14	45,774	51,471	89,755	424,415	413,602	261,523	1,286,540
15-19	64,117	57,064	94,640	341,004	305,360	187,794	1,049,979
20-24	78,613	88,732	124,208	252,073	124,759	121,620	790,005
25-29	39,791	31,612	47,815	154,439	120,546	90,695	484,898
30-34	53,597	43,629	63,731	254,561	203,634	112,995	732,147
35-39	42,011	34,702	49,134	216,404	170,736	95,098	608,085
40-44	35,045	30,278	43,236	193,174	153,045	88,175	542,953
45-49	32,821	24,943	34,015	140,803	102,784	66,475	401,841
50-54	24,583	16,988	23,606	86,851	68,229	62,934	283,191
55-59	18,313	12,640	13,979	59,729	36,602	30,086	171,349
60-64	17,768	11,334	15,777	58,182	46,181	50,896	200,138
65+	24,578	15,893	18,079	85,493	58,304	54,620	256,967
Total	552,316	506,074	782,307	3,087,849	2,657,675	1,860,363	9,446,584
Females							
0-4	36,546	40,351	72,585	375,792	383,100	278,173	1,186,547
5-9	37,609	43,820	80,811	403,697	402,375	275,768	1,244,080
10-14	42,466	46,751	78,339	370,285	337,495	200,263	1,075,599
15-19	52,722	46,974	73,702	321,772	275,483	162,094	932,747
20-24	47,537	35,363	55,711	221,194	194,233	138,608	692,646
25-29	33,767	25,602	43,532	195,388	193,413	128,257	619,959
30-34	42,428	31,697	50,784	229,827	213,470	132,442	700,648
35-39	39,783	29,720	46,941	199,696	169,498	93,556	579,194
40-44	35,229	27,049	41,626	182,625	163,731	108,518	558,778
45-49	32,207	22,507	28,822	138,723	103,347	53,399	379,005
50-54	28,806	20,479	29,464	140,420	129,665	85,873	434,707
55-59	22,412	14,823	15,514	87,750	53,582	25,602	219,683
60-64	22,375	16,756	23,316	119,748	104,391	63,092	349,678
65+	32,751	23,861	24,737	141,059	92,259	55,662	370,329
Total	506,638	425,753	665,884	3,127,970	2,816,039	1,801,309	9,343,593

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part B 1950							
Males							
0-4	51,123	57,768	102,165	479,374	504,149	390,542	1,585,121
5-9	47,999	53,142	92,025	404,788	417,761	322,823	1,338,538
10-14	46,063	51,591	88,788	400,441	405,436	283,253	1,275,572
15-19	73,033	60,490	98,020	400,668	385,181	253,943	1,271,335
20-24	85,009	76,805	131,902	291,041	228,648	177,478	990,883
25-29	54,547	26,828	53,682	251,731	190,636	149,606	727,030
30-34	50,047	49,724	57,592	140,459	124,257	102,236	524,315
35-39	44,964	42,810	52,735	244,674	192,124	111,113	688,420
40-44	47,367	31,989	50,390	187,206	150,145	84,878	551,975
45-49	36,174	31,057	39,901	176,251	134,652	81,765	499,800
50-54	27,625	22,586	29,839	139,588	106,826	63,142	389,606
55-59	19,710	12,142	15,059	69,763	49,749	47,877	214,300
60-64	17,978	15,627	16,678	59,849	44,316	42,637	197,085
65+	27,360	19,215	19,840	85,159	60,644	60,883	273,101
Total	628,999	551,774	848,616	3,331,000	2,994,523	2,172,177	10,527,089
Females							
0-4	49,872	57,730	97,766	461,487	483,081	359,327	1,509,263
5-9	46,488	52,998	88,608	381,115	388,523	280,598	1,238,330
10-14	44,099	50,170	80,713	350,108	339,463	217,598	1,082,151
15-19	53,871	55,178	82,013	369,687	346,503	212,423	1,119,675
20-24	58,974	51,116	75,552	307,322	286,422	194,772	974,158
25-29	44,082	29,013	52,420	236,532	226,637	163,898	752,582
30-34	41,326	38,895	50,993	163,055	171,474	125,573	591,316
35-39	42,350	36,501	47,255	196,536	175,302	102,793	600,737
40-44	43,642	31,069	47,191	198,486	174,704	100,854	595,946
45-49	34,907	27,186	32,610	148,641	126,240	76,216	445,800
50-54	34,075	26,192	34,999	162,872	134,917	78,990	472,045
55-59	21,541	15,252	16,351	91,029	71,489	44,838	260,500
60-64	27,997	22,953	26,424	125,309	97,797	58,731	359,211
65+	38,396	30,635	29,045	153,631	104,606	62,067	418,380
Total	581,620	524,888	761,940	3,345,815	3,127,159	2,078,682	10,420,104

Females									
0-4	1,399.0	1,328.0	1,245.0	1,574.0	1,962.0	2,163.4	2,356.4	2,693.2	2,752.0
5-9	1,074.0	1,192.0	1,176.0	1,174.0	1,498.0	1,867.2	2,181.1	2,399.7	2,574.5
10-14	809.3	1,044.0	1,117.0	1,106.0	1,106.0	1,496.9	1,822.2	2,173.7	2,502.2
15-19	563.1	780.2	1,018.0	1,194.0	1,141.0	1,091.7	1,407.4	1,820.1	2,219.7
20-24	683.7	538.3	709.3	983.7	1,115.0	1,123.0	1,129.3	1,346.0	1,701.2
25-29	680.1	655.7	575.9	698.9	956.2	1,107.4	1,093.3	1,082.6	1,307.6
30-34	590.0	656.0	649.9	554.7	699.2	959.8	1,105.7	1,131.9	1,066.7
35-39	515.2	566.4	577.0	598.0	527.6	700.5	944.6	1,105.0	1,148.9
40-44	442.3	490.5	519.4	557.0	588.0	525.2	648.9	859.6	1,017.6
45-49	386.4	416.4	448.0	520.8	550.4	578.4	497.4	650.8	952.6
50-54	332.2	359.9	381.2	419.8	479.8	538.3	548.0	472.1	596.1
55-59	278.6	297.4	292.8	337.5	391.8	458.0	515.1	544.8	484.5
60-64	213.3	236.0	257.3	269.4	298.2	363.8	395.9	416.8	433.3
65-69	159.3	164.0	172.1	203.8	219.7	261.2	331.6	389.2	451.2
70-74	101.8	106.8	111.0	117.8	150.2	176.4	199.2	238.7	267.9
75+	89.3	90.3	94.2	111.1	148.3	179.7	217.9	268.9	303.1
Subtotal	8,317	8,922	9,344	10,420	11,831	13,591	15,394	17,598	19,780
Total	16,347	17,821	18,790	20,947	24,065	27,755	31,391	35,605	40,198

---

[a] Includes province of Hatay, annexed in 1939.

[b] Preliminary: estimated from a one percent sample of the 1975 census.

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part C 1955							
Males							
0-4	77,909	85,441	164,721	558,347	610,046	489,040	1,985,504
5-9	67,679	79,421	148,881	485,189	503,988	391,878	1,677,036
10-14	62,405	68,055	122,250	383,616	382,733	276,749	1,295,808
15-19	97,437	75,322	138,168	356,702	333,466	247,160	1,248,255
20-24	117,603	135,143	227,681	295,676	224,347	209,753	1,210,203
25-29	97,519	69,301	117,198	288,674	230,292	156,500	959,484
30-34	72,323	57,518	85,221	223,471	171,091	139,413	749,037
35-39	45,525	36,411	56,518	148,826	132,841	99,331	519,452
40-44	57,160	47,787	69,572	215,298	176,704	100,254	666,775
45-49	44,183	37,626	50,224	184,462	135,671	72,843	525,009
50-54	35,939	32,431	45,045	173,405	138,896	79,650	505,366
55-59	29,372	23,896	30,550	113,048	81,641	48,717	327,224
60-64	20,125	15,767	21,102	69,872	57,772	58,415	243,053
65+	32,256	23,586	27,291	97,629	68,305	72,138	321,205
Total	857,435	787,705	1,304,422	3,594,215	3,247,801	2,441,841	12,233,419
Females							
0-4	69,795	80,694	151,808	540,869	588,189	448,010	1,879,365
5-9	64,412	76,304	140,675	459,561	473,412	347,622	1,561,986
10-14	54,084	61,212	101,603	344,163	320,223	209,301	1,090,586
15-19	59,249	61,979	102,166	341,221	319,146	204,346	1,088,107
20-24	66,601	64,197	104,925	334,571	318,692	222,113	1,111,099
25-29	68,063	59,063	95,831	303,483	296,589	198,621	1,021,650
30-34	53,007	44,458	69,385	210,911	200,563	152,963	731,287
35-39	39,803	32,835	52,764	157,142	145,743	97,553	525,840
40-44	46,788	37,467	56,715	194,363	176,153	110,059	621,545
45-49	41,482	32,472	44,433	164,177	126,302	64,261	473,127
50-54	38,407	30,804	44,839	169,519	150,464	94,174	528,207
55-59	31,264	24,378	27,627	114,837	75,430	35,237	308,773
60-64	27,311	22,835	30,951	124,673	109,832	71,684	387,286
65+	47,629	38,118	41,107	181,979	121,598	72,056	502,487
Total	707,895	666,816	1,064,829	3,641;471	3,422,333	2,327,999	11,831,343

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part D 1960							
Males							
0-4	87,964	124,784	225,878	578,497	651,961	515,622	2,184,706
5-9	86,656	126,238	223,95[illegible]	553,824	604,831	481,354	2,076,854
10-14	82,458	116,801	198,568	453,532	475,720	364,111	1,691,190
15-19	107,246	112,258	184,880	320,203	296,749	228,606	1,249,942
20-24	108,123	182,638	258,351	249,481	200,786	178,851	1,178,230
25-29	108,414	107,167	159,001	319,563	273,856	189,521	1,157,522
30-34	94,291	94,845	139,312	287,012	247,523	165,325	1,028,308
35-39	69,746	71,998	96,030	214,840	168,756	128,338	749,708
40-44	43,963	43,687	62,004	134,165	125,445	96,721	505,985
45-49	54,822	56,515	71,303	196,253	153,667	77,877	610,437
50-54	43,668	45,053	55,196	179,073	142,304	83,178	548,472
55-59	32,611	35,623	43,142	149,752	110,794	52,800	424,722
60-64	27,262	27,481	35,075	112,332	94,162	72,647	368,959
65+	38,014	35,191	38,394	112,685	83,371	81,202	388,857
Total	985,238	1,180,279	1,791,085	3,861,201	3,629,928	2,716,158	14,163,889
Females							
0-4	84,227	120,827	214,287	557,045	625,511	477,026	2,078,923
5-9	82,240	120,398	209,603	525,216	561,931	428,285	1,927,673
10-14	73,160	102,663	164,507	425,792	423,845	298,547	1,488,514
15-19	68,128	84,127	126,921	307,004	282,724	190,334	1,059,230
20-24	73,957	84,551	134,576	313,377	300,953	220,440	1,127,854
25-29	75,666	85,614	133,055	330,330	331,804	220,846	1,177,315
30-34	71,336	76,943	113,237	274,183	266,901	183,190	985,790
35-39	57,915	60,780	83,098	200,790	173,908	117,273	693,764
40-44	39,283	38,608	59,040	147,147	152,608	111,745	548,431
45-49	46,222	43,328	55,396	161,938	128,675	64,423	499,982
50-54	43,634	41,551	57,362	177,159	159,238	102,376	581,320
55-59	36,062	34,093	39,080	128,645	89,690	41,860	369,430
60-64	33,008	33,207	43,601	142,949	125,047	83,558	461,367
65+	57,288	55,395	56,058	205,013	136,215	81,373	591,342
Total	842,126	982,085	1,489,821	3,896,578	3,759,048	2,621,274	13,590,932

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part E 1965							
Males							
0-4	100,684	150,141	304,989	566,996	685,907	550,623	2,359,340
5-9	110,463	168,269	315,207	593,197	682,567	549,137	2,418,840
10-14	105,638	165,479	290,501	517,076	550,899	431,493	2,061,086
15-19	142,907	162,003	273,437	364,024	340,388	265,850	1,548,609
20-24	112,222	207,775	287,033	240,384	185,395	180,272	1,213,081
25-29	103,584	113,934	175,547	271,641	222,934	169,081	1,056,721
30-34	103,677	118,016	179,634	297,011	259,556	182,513	1,140,407
35-39	91,308	105,601	154,597	265,542	226,994	155,106	999,148
40-44	67,458	76,257	101,607	190,792	149,277	120,409	705,800
45-49	43,145	46,131	62,094	120,089	101,401	73,355	446,215
50-54	54,082	59,563	76,034	186,793	151,222	85,430	613,124
55-59	39,070	44,085	51,841	152,431	110,491	52,291	450,209
60-64	29,199	35,712	47,080	140,905	121,088	79,495	453,479
65+	46,073	49,952	57,960	156,303	121,987	98,628	530,903
Total	1,149,510	1,502,918	2,377,561	4,063,184	3,910,110	2,993,681	15,996,964
Females							
0-4	95,815	144,857	289,204	550,152	664,517	520,287	2,264,832
5-9	105,701	161,090	294,223	564,567	640,069	486,617	2,252,267
10-14	95,525	145,026	242,742	483,551	494,419	351,033	1,812,296
15-19	95,208	124,630	198,813	366,054	346,223	234,837	1,365,765
20-24	84,506	100,807	164,427	286,934	281,261	216,586	1,134,521
25-29	80,676	100,981	162,749	294,523	305,365	218,260	1,162,554
30-34	79,000	99,631	151,795	297,836	300,208	207,464	1,135,934
35-39	77,149	90,495	133,234	256,489	230,730	147,712	935,809
40-44	57,294	62,364	86,930	181,310	164,985	124,780	677,663
45-49	39,490	40,658	55,619	122,487	105,736	66,131	430,121
50-54	48,711	49,707	68,435	173,920	154,557	96,315	591,645
55-59	41,137	41,960	49,708	138,416	99,065	45,331	415,617
60-64	36,503	40,637	55,618	151,860	133,284	84,184	502,086
65+	68,379	73,569	78,014	236,567	164,051	92,758	713,338
Total	1,005,094	1,276,412	2,031,511	4,014,677	4,084,472	2,892,291	15,394,457

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part F	1970						
Males							
0-4	134,208	233,596	432,755	559,660	692,281	609,221	2,661,721
5-9	134,688	213,996	443,357	553,484	680,894	584,572	2,610,991
10-14	151,154	234,356	435,943	522,212	568,046	451,730	2,363,441
15-19	189,172	241,424	411,060	397,130	375,049	310,851	1,924,686
20-24	163,945	254,663	388,990	267,685	219,179	202,173	1,496,635
25-29	134,295	148,803	227,458	238,936	201,176	157,531	1,108,199
30-34	105,270	133,219	197,970	233,491	194,369	154,856	1,019,175
35-39	107,746	136,433	204,674	272,292	233,238	162,993	1,117,376
40-44	93,088	116,626	165,111	230,735	184,819	131,102	921,481
45-49	69,551	80,785	107,290	172,115	123,852	91,152	644,745
50-54	45,068	50,381	72,120	114,589	98,630	76,302	457,090
55-59	50,284	55,351	72,190	153,784	114.212	51,230	497,051
60-64	37,749	45,402	60,368	141,793	116,172	74,971	476,455
65+	57,754	70,890	91,760	209,621	166,828	111,087	707,940
Total	1,473,972	2,015,925	3,311,046	4,067,527	3,968,745	3,169,771	18,006,986
Females							
0-4	129,763	203,102	404,356	553,412	699,839	604,299	2,594,771
5-9	130,890	190,269	410,243	546,750	662,433	543,390	2,483,975
10-14	131,816	209,807	366,971	516,283	552,171	390,207	2,167,255
15-19	131,666	187,609	312,455	425,722	418,782	294,485	1,770,719
20-24	123,771	149,271	251,801	307,093	296,636	226,958	1,355,530
25-29	100,552	123,324	208,378	260,745	264,127	196,827	1,153,953
30-34	91,238	133,009	200,247	263,112	276,986	201,117	1,165,709
35-39	93,105	121,622	187,426	277,336	253,631	164,136	1,097,256
40-44	83,244	100,198	146,586	228,122	203,352	138,452	899,954
45-49	60,964	64,242	88,454	154,742	118,519	77,214	564,135
50-54	43,746	50,477	75,652	130,138	125,045	91,267	516,325
55-59	47,421	48,107	62,661	135,221	99,862	47,304	440,576
60-64	43,836	49,731	72,858	151,162	130,523	81,825	529,935
65+	82,332	95,697	113,782	267,021	193,277	105,988	858,097
Total	1,294,344	1,726,465	2,901,870	4,216,859	4,295,183	3,163,469	17,598,190

[a] Persons with ages reported unknown are redistributed in proportion to the number of persons in each age group.

Glossary

AGE HEAPING A tendency for enumerators or respondents to report certain ages instead of others; also called age preference or digit preference. Preference for ages ending in 0 or 5 is widespread.

AGE PATTERN OF FERTILITY The relative distribution of a set of age-specific fertility rates. It expresses the relative contribution of each age group to total fertility.

AGE RATIO The ratio of the population in a given age group to the average of the populations in the two neighboring age groups, times 100.

AGE-SPECIFIC FERTILITY RATE The number of births occurring during a specified period to women of a specified age or age group, divided by the number of person-years-lived during that period by women of that age or age group. When an age-specific fertility rate is calculated for a calendar year, the number of births to women of the specified age is usually divided by the midyear population of women of that age.

AGE-SPECIFIC MORTALITY RATE The number of deaths occurring during a specified period to persons (usually specified by sex) of a specified age or age group, divided by the number of person-years-lived during that period by the persons of that age or age group. When an age-specific mortality rate is calculated for a calendar year, the number of deaths to persons of the specified age is usually divided by the midyear population of persons of that age. Age-specific mortality rates are generally denoted by ${}_nM_x$, the annual death rate to persons aged x to x + n.

AGE STANDARDIZATION A procedure of adjustment of crude rates (birth, death, or other rates) designed to

reduce the effect of differences in age structure when comparing rates for different populations.

BIRTH HISTORY A report of the number and dates of all live births experienced by a particular woman; see also pregnancy history. The sex of each child, the survival of each child to the date of the interview, and, where pertinent, the date of death are also generally recorded.

BIRTH ORDER The ordinal number of a given live birth in relation to all previous live births of the same woman (e.g., 5 is the birth order of the fifth live birth occurring to the same woman).

BIRTH RATE See crude birth rate.

CHANDRASEKARAN-DEMING TECHNIQUE A procedure to estimate the coverage of two independent systems collecting information about demographic or other events, based on the assumption that the probability of an event being recorded by one system is the same whether or not the event is recorded by the other system. The events from both systems are matched to establish M, the number of events recorded by both systems; U_1, the number recorded only by system 1; and U_2, the number recorded only by system 2. The Chandrasekaran-Deming formula then estimates total events, N, as

$$\hat{N} = M + U_1 + U_2 + \frac{U_1 U_2}{M}.$$

CHILDBEARING AGES The span within which women are capable of bearing children, generally taken to be from age 15 to age 49 or, sometimes, to age 44.

CHILDREN EVER BORN(E) The number of children ever borne alive by a particular woman; synonymous with parity. In demographic usage, stillbirths are specifically excluded.

COHORT A group of individuals who experienced the same class of events in the same period. Thus an age cohort is a group of people born during a particular period, and a marriage cohort is a group of people who married during a particular period. The effects of a given set of mortality or fertility rates are often illustrated by applying them to hypothetical cohorts.

COHORT FERTILITY The fertility experienced over time by a group of women or men who form a birth or a marriage cohort. The analysis of cohort fertility is contrasted with that of period fertility.

CRUDE BIRTH RATE The number of births in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as births per 1,000 population. The crude birth rate for a single year is usually calculated as the number of births during the year divided by the midyear population.

CRUDE DEATH RATE The number of deaths in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as deaths per 1,000 population. The crude death rate for a single year is usually calculated as the number of deaths during the year divided by the midyear population.

CUMULATED FERTILITY An estimate of the average number of children ever borne by women of some age x, obtained by cumulating age-specific fertility rates up to age x; also often calculated for age groups.

DEATH RATE See crude death rate.

DE FACTO POPULATION A population enumerated on the basis of those present at a particular time, including temporary visitors and excluding residents temporarily absent. See de jure population.

DE JURE POPULATION A population enumerated on the basis of normal residence, excluding temporary visitors and including residents temporarily absent. See de facto population.

DIGITAL PREFERENCE See age heaping.

DUAL RECORD SYSTEM See Chandrasekaran-Deming Technique

EXPECTATION OF LIFE AT BIRTH The average number of years that a member of a cohort of births would be expected to live if the cohort were subject to the mortality conditions expressed by a particular set of age-specific mortality rates. Denoted by the symbol e(o) in life table notation.

FERTILITY HISTORY Either a birth history or a pregnancy history.

FORWARD SURVIVAL A procedure for estimating the age distribution at some later date by projecting forward an observed age distribution. The procedure uses survival ratios, often obtained from model life tables. The procedure is basically a form of population projection without the introduction of new entrants (births) to the population.

GENERAL FERTILITY RATE The ratio of the number of live births in a period to the number of person-years-lived by women of childbearing ages during the period. The

general fertility rate for a year is usually calculated as the number of births divided by the number of women of childbearing ages at midyear.

GROSS REPRODUCTION RATE The average number of female children a woman would have if she survived to the end of her childbearing years and if, throughout, she were subject to a given set of age-specific fertility rates and a given sex ratio at birth. This number provides a measure of replacement fertility in the absence of mortality.

GROWTH RATE The increase or decrease of a population in a period divided by the number of person-years-lived by the population during the same period. The increase in a population is the result of a surplus (or deficit) of births over deaths and a surplus (or deficit) of immigrants over emigrants. (The annual increase is often expressed as a fraction of the total population at the beginning of the year, but this convention has the inconvenient characteristic of not being readily defined for a five-year interval and of being unequal to the difference between the birth rate and the death rate even in the absence of migration.) See also rate of natural increase.

INFANT MORTALITY RATE The number of deaths of children under 1 year of age occurring in the same year; also used in a more rigorous sense to mean the number of deaths that would occur under 1 year of age in a life table with a radix of 1,000, in which sense it is denoted by the symbol $_1q_0$.

LIFE TABLE A listing of the number of survivors at different ages (up to the highest age attained) in a hypothetical cohort subject from birth to a particular set of age-specific mortality rates. The rates are usually those observed in a given population during a particular period of time. The survivors of the radix to age x are generally denoted by $l(x)$. The tabulations commonly accompanying a life table include other features of the cohort's experience: its expectation of life at each age x, denoted by $e(x)$; the probability of surviving from each age x to age x + n, denoted by $_nq_x$; the person-years-lived by the hypothetical cohort as it ages from age x to age x + n, denoted by $_nL_x$ (also equivalent to the population aged x, x + n in a stationary population experiencing a number of births each year equal to the radix of the life table); and the person-years-lived

by the hypothetical cohort from age x onward, denoted by T(x).

LOGIT The logit of a proportion p is $1/2 \ln[p/(1 - p)]$. As a linearizing transformation, the logit has been proposed as the basis of a model life table system in which the logit of a probability of dying by age x ($_xq_0$) is related linearly to the logit of a standard probability of dying by age x ($_xq_0^s$) so that

$$\text{logit } ({}_xq_0) = \alpha + \beta \, [\text{logit } ({}_xq_0^s)],$$

where α is a measure of mortality level relative to the standard and β is a parameter that alters the shape of the standard mortality function.

MARITAL FERTILITY Any measure of fertility in which the births (in the numerator) are births to married women and in which the number of person-years-lived (in the denominator) also pertains to married women. In some instances, the designation "married" includes persons in consensual unions.

MEDIAN The value associated with the central member of a set that is ordered by size or some other characteristic expressed in numbers.

MEAN AGE OF CHILDBEARING The average age at which a mortality-free cohort of women bear their children according to a set of age-specific fertility rates.

MEAN AGE OF CHILDBEARING IN THE POPULATION The average age of the mothers of the children born in a population during a year. This measure incorporates the effects of both mortality and the age distribution.

MIGRATION RATE Number of migrants during a specified period divided by the person-years-lived of the population exposed to migration. Also see population change due to migration.

MODEL LIFE TABLE An expression of typical mortality experience derived from a group of observed life tables.

MOVING AVERAGES The successive averaging of two or more adjacent values of a series in order to remove sharp fluctuations.

MYERS INDEX An index of digit preference that essentially sums in turn the population ending in each digit over some age range, often 10-89, expressing the total as a percentage of the total population, and which avoids the bias introduced by the fact that the population is not evenly distributed among all ages by repeating the calculations 10 times, once for each

starting digit, and averaging the results. The difference between the average percentage for each digit and the expected value of 10 percent provides a measure of the preference for or avoidance of the digit over the age range considered.

NATURAL FERTILITY The age pattern of marital fertility observed in non-contraceptive populations where reproductive behavior is not affected by the number of children already born.

NET MIGRATION The difference between gross immigration and gross emigration.

NET REPRODUCTION RATE The average number of female children born per woman in a cohort subject to a given set of age-specific fertility rates, a given set of age-specific mortality rates, and a given sex ratio at birth. This rate measures replacement fertility under given conditions of fertility and mortality: it is the ratio of daughters to mothers assuming continuation of the specified conditions of fertility and mortality.

OWN-CHILDREN METHOD A refinement of the reverse-survival procedure for fertility estimation, whereby estimates of age-specific fertility rates for the recent past are obtained by relating mothers to their own children, using information on relationship and other characteristics available from a census or survey.

PARITY See children ever born.

PARTIAL BIRTH RATE The proportion of the population that enters (that is, is "born" into) a given age category in a year. The age categories used are normally open-ended, thus the partial birth rate x+ designates the proportion of the population becoming x years and older.

PARTIAL DEATH RATE The proportion of the population that leaves (that is, "dies" out of) a given age category in a year. See partial birth rate.

PERIOD FERTILITY The fertility experienced during a particular period of time by women from all relevant birth or marriage cohorts; see also cohort fertility.

P/F RATIO METHOD A consistency check for survey information on fertility. Information on recent fertility is cumulated to obtain measures that are equivalent to average parities. Lifetime fertility in the form of reported average parities by age group (P) can then be compared for consistency with the parity-equivalents (F) by calculating the ratio P/F for successive age groups. If certain assumptions

about error patterns are met, an improved estimate of fertility can sometimes be obtained by correcting the age pattern of current fertility to agree with the level of lifetime fertility reported by younger women.

POPULATION CHANGE DUE TO MIGRATION The sum of in-migrants minus out-migrants during a specified period of time. The change may also be expressed as a rate by dividing the change by person-years-lived in the population during the same period.

PREGNANCY HISTORY A report of the number and the dates of occurrence of all the pregnancies experienced by a particular woman. The outcome of the pregnancy--live birth, stillbirth, fetal death--is also recorded.

RADIX The hypothetical birth cohort of a life table. Common values are 1, 1,000, and 100,000.

RATE OF NATURAL INCREASE The difference between the births and deaths occurring during a given period divided by the number of person-years-lived by the population during the same period. This rate, which specifically excludes changes resulting from migration, is the difference between the crude birth rate and the crude death rate.

RETROSPECTIVE SURVEY A survey that obtains information about demographic events that occurred in a given past period, generally terminating at the time of the survey.

REVERSE PROJECTION See reverse survival.

REVERSE SURVIVAL A technique to estimate an earlier population from an observed population, allowing for those members of the population who would have died according to observed or assumed mortality conditions. It is used as a method of estimating fertility by calculating from the observed number of survivors of a given age x the expected number of births that occurred x years earlier. (In situations for which both fertility and mortality are known or can be reliably estimated, reverse survival can be used to estimate migration.)

ROBUSTNESS A characteristic of estimates that are not greatly affected by deviations from the assumptions on which the estimation procedure is based.

SEX RATIO AT BIRTH The number of male births for each female birth, or male births per 100 female births.

SINGULATE MEAN AGE AT MARRIAGE (SMAM) A measure of the mean age at first marriage, derived from a set of proportions of people single at different ages or in

different age groups, usually calculated separately for males and females.

STABLE POPULATION A population exposed for a long time to constant fertility and mortality rates, and closed to migration, establishes a fixed age distribution and constant growth rate characteristic of the vital rates. Such a population, with a constant age structure and constant rate of growth, is called a stable population.

STATIONARY POPULATION A stable population that has a zero growth rate, with constant numbers of births and deaths per year. Its age structure is determined by the mortality rates and is equivalent to the person-years-lived ($_nL_x$) column of a conventional life table.

SURVIVAL RATIO The probability of surviving between one age and another; often computed for age groups, in which case the ratios correspond to those of the person-years-lived function, $_nL_x$, of a life table. Also called survivorship probabilities.

SURVIVORSHIP PROBABILITIES See survival ratio.

SYNTHETIC PARITY The average parity calculated for a hypothetical cohort exposed indefinitely to a set of period age-specific fertility rates.

TOTAL FERTILITY RATE (TFR) The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given set of age-specific fertility rates; also referred to as total fertility. It is frequently used to compute the consequence of childbearing at the rates currently observed.

UNITED NATIONS AGE-SEX ACCURACY INDEX An index of age reporting accuracy that is based on deviations from the expected regularity of population size and sex ratio, age group by age group. The index is calculated as the sum of (1) the mean absolute deviation from 100 of the age ratios for males, (2) the mean absolute deviation from 100 of the age ratios for females, and (3) three times the mean of the absolute difference in reported sex ratios from one age group to the next. The United Nations defines age-sex data as "accurate," "inaccurate," or "highly inaccurate" depending on whether the index is less than 20, 20 to 40, or greater than 40.

WHIPPLE'S INDEX A measure of the quality of age reporting based on the extent of preference for a particular target digit or digits. The index

essentially compares the reported population at ages ending in the target digit or digits with the population expected on the assumption that population is a linear function of age. For a particular age range, often 23 to 62, the population with ages ending in the target digits is divided by one-tenth of the total population, the result then being multiplied by 100 and divided by the number of different target digits. A value of 100 indicates no preference for those digits, whereas values over 100 indicate positive preference for them.

References

Abadan, Nermin (1964) Batı Almanya'daki Türk Iscileri ve Sorunları (Turkish Workers in West Germany and Their Problems). Ankara: State Planning Organization.

Adlakha, Arjun L. (1970) A Study of Infant Mortality in Turkey. Sociology dissertation. University of Michigan, University Microfilms 71-4553.

Bongaarts, John (1978) A framework for analyzing the proximate determinants of fertility. Population and Development Review 4(1):105-132.

Brass, William (1968) Methods of analysis and estimation. Pp. 88-150 in W. Brass et al., ed., The Demography of Tropical Africa. Princeton, N.J.: Princeton University Press.

Coale, Ansley J. (1971) Age patterns of marriage. Population Studies 25(2):193-214.

Coale, Ansley J., and P. Demeny (1966) Regional Model Life Tables and Stable Populations. Princeton, N.J.: Princeton University Press.

Coale, Ansley J., Allan G. Hill, and T. James Trussell (1975) A new method of estimating standard fertility measures from incomplete data. Population Index 41:182-210.

Coale, Ansley J., and T. James Trussell (1974) Model fertility schedules: variations in the structure of childbearing in human populations. Population Index 40(2):185-258.

Das Gupta, Prithwis (1975) A general method of correction for age misreporting in census populations. Demography 12(2):303-312.

Demeny, Paul, and Frederic C. Shorter (1968) Estimating Turkish Mortality, Fertility, and Age Structure: Application of Some New Techniques. Faculty of Economics, Istanbul University, Pat. No. 1306.

Fisek, Nusret H. (1978) Türkiye'de Asırı Dogurganlık ve Kullanilan Gebeligi Önleyici Yöntemler (Excess Fertility and Contraceptive Methods in Turkey). In S. Uner, et al. *Türkeiyede Nüfus Yapısı ve Nüfus Sorunlar: 1973 Arastırması* (Population Structure and Population Problems in Turkey: 1973 Survey). Hacettepe University, Publication No. D-25.

Geray, Cevat (1962) *Türkiye'den ve Türkiye'ye Göcler ve Göcmelerin Iskanı 1923-1961* (Migration from and to Turkey and the Settlement of Immigrants). Turk Iktisadi Gelismesi Arastirma Projesi, No. 9, Ankara.

Hacettepe Institute of Population Studies (1980) *Turkish Fertility Survey, 1978*. First Report, Vol. II: Statistical Tables. Hacettepe University.

Hajnal, John (1953) Age at marriage and proportions marrying. *Population Studies* 7:111-132.

Institute of Community Medicine (1975) *An Account of the Activities of the Etimesgut Rural Health Disrict, 1970-1974*. Hacettepe University, School of Medicine.

Macura, Miroslav (1975a) Estimates of Infant Mortality Trends in Turkey, 1944-67. Paper presented to the Second Conference on Turkish Demography, Hacettepe Institute of Population Studies, Cesme, Turkey.

Macura, Miroslav (1975b) Estimating Trends of Infant Mortality from Pregnancy Histories. *Seminar on Infant Mortality in Relation to the Level of Fertility*. (Bangkok, May 6-12, 1975.) Paris: Committee for International Coordination of National Research in Demography.

Ntozi, James Patrick Manyenye (1978) The Demeny-Shorter and three-census methods for correcting age data. *Demography* 15(4):509-521.

Özbay, Ferhunde (1979) Türkiye'de 1963, 1968 ve 1973 Yıllarında Aile Planlamasi Uygulamalarında ve Dogurganlıktakı Degismeler (Changes in Contraceptive Use and Fertility in Turkey 1963, 1968 and 1973). *Istatistik* 1(2):31-47. Istatiskciler Dernegi, Ankara.

Özbay, Ferhunde (1978) Education and fertility in rural Turkey. *Studies in Development* 22/23. Journal of Middle East Technical University, Ankara.

Özbay, Ferhunde, and Frederic C. Shorter (1970) Turkey: changes in birth control practices, 1963 to 1968. *Studies in Family Planning* 51:1-7.

Özbay, Ferhunde, Frederic C. Shorter, and S. Yener (1977) Accounting for the Trend of Fertility in Turkey. Paper presented to UN/UNFPA Expert Group Meeting on Demographic Transition and Socioeconomic Development, Istanbul.

Shorter, Frederic C. (1980) Computational Methods for Regional Population Projections and Reverse Projections. *Regional Papers*. Population Council, Cairo.

Shorter, Frederic C., and David Pasta (1974) *Computational Methods for Population Projections with Particular Reference to Development Planning*. The Population Council, New York.

Sullivan, Jeremiah (1972) Models for the estimation of the probability of dying between birth and exact ages of early childhood. *Population Studies* 26(1):79-97.

Sümbüloglu, Kadir (1978) Il ve Ilce Merkezlerinden Devlet Istatistik Enstitüsüne Bildirilen Ölümler Sayisal Yönden Yeterli: Midir?" (Are the Numbers of Deaths Reported From Province and District Centers to the State Institute of Statistics Numerically Complete?). Faculty of Medicine, Hacettepe University.

Taeuber, Irene (1958) Population and modernization in Turkey. *Population Index* 24(2):101-122.

Tekce, Belgin (1974) Urbanization and Migration in Turkey. Sociology dissertation. Princeton University, University Microfilms 76-269.

Tekce, Belgin (1975) *Migration to Cities in Turkey: Estimates for 1955-60 and 1960-65*. Ankara: State Institute of Statistics.

Tekce, Belgin (1979) The Yozgat (Turkey) Maternal and Child Health and Family Planning Project: Baseline Information on Socioeconomic and Demographic Conditions. *Regional Papers*. Population Council, Cairo.

Timur, Serim, et al. (1971) *Türkiyede Aile Yapısı ve Nüfus Sorunları Arastırmasının Veri Toplam Teknikleri (1968)* (Methodology of Survey on Family Structure and Population Problems in Turkey). Hacettepe University, Publication No. D-9.

Timur, Serim (1974) Fertility. In Figen Karadayi, et al., *The Population of Turkey*. World Population Year Series. Hacettepe University and CICRED: Institute of Population Studies.

Toros, Aykut (1978) 1973 Arastırmasında Dogurganlık (Fertility in the 1973 Survey). In S. Uner et al. *Türkeiyede Nüfus Yapısı ve Nüfus Sorunlar: 1973 Arastırması* (Population Strucutre and Population Problems in Turkey: 1973 Survey). Hacettepe University, Publication No. D-25.

Trussell, T. James (1975) A re-estimation of the multiplying factors for the Brass technique for determining childhood survivorship rates. Population Studies 29(1):97-108.

Turkay, Orhan (1962) Türkiye'de Nüfus Artısı ve Iktısadı Gelisme (Population Growth and Economic Development in Turkey). Ankara.

Turkey, Ministry of Health and Social Welfare (1973) Saglik Hizmetlerinde 50 Yil (50 Years in Health Services). Ankara: Ministry of Health and Welfare Publications.

Turkey, Regional Planning Office (1968) Il ve Ilcelerin Nüfus Düzeltmeleri: 1935-1965 (Adjustments of Province and District Population: 1935-1965). Ankara: Ministry of Housing and Resettlement.

Turkey, School of Public Health (1970) Vital Statistics from the Turkish Demographic Survey: 1966-67. Ankara: Ministry of Health and Social Welfare.

Turkey, State Institute of Statistics (1971) Türkiye Hayat Tablolari, 1966-67 (Life Tables of Turkey, 1966-67). Publication No. 623, Ankara.

Turkey, State Institute of Statistics (1978) Türkiye Nüfus Arastırması: 1974-75 (Turkish Population Survey: 1974-75). Publication No. 841, Ankara.

U. N. (1967) Manual IV: Methods of Estimating Basic Demographic Measures from Incomplete Data. Department of Economic and Social Affairs, Population Studies, No. 42.

Yener, Samira (Berksan) (1969) Marriage patterns and their effect on fertility in Turkey. In Turkish Demography: Proceedings of a Conference. Hacettepe University: Institute of Population Studies.

R 6000-5.8

COMMITTEE ON
POPULATION AND DEMOGRAPHY

Report No. 9

The Estimation of Recent Trends in Fertility and Mortality in Egypt

Panel on Egypt
Committee on Population and Demography
Assembly of Behavioral and Social Sciences
National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1982

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

Library of Congress Catalog Card Number 81-86662

International Standard Book Number 0-309-03238-5

Available from

National Academy Press
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Printed in the United States of America

PANEL ON EGYPT

GAMAL ASKAR (Co-Chair)*, Central Agency for Public Mobilisation and Statistics, Cairo
ANSLEY J. COALE (Co-Chair), Office of Population Research, Princeton University
MEDANI DESOUKI, Faculty of Economics and Political Science, Cairo University
MOHAMED EL-BADRY, Cairo Demographic Center
MOSTAFA H. EL GUINDY, Central Agency for Public Mobilisation and Statistics, Cairo
MOHAMED HUSSEIN MOHAMED KHALIL, High Institute of Public Health, Alexandria, Egypt
W. PARKER MAULDIN, Population Division, Rockefeller Foundation, New York
NAZEK NOSSEIR, Social Research Center, The American University in Cairo
FREDERIC C. SHORTER, The Population Council, Cairo

ROBERT J. LAPHAM, Study Director
JANE S. DURCH, Research Assistant

*deceased January 1981

COMMITTEE ON POPULATION AND DEMOGRAPHY

ANSLEY J. COALE (Chair), Office of Population Research, Princeton University
WILLIAM BRASS, Centre for Population Studies, London School of Hygiene and Tropical Medicine
LEE-JAY CHO, East-West Population Institute, East-West Center, Honolulu
RONALD FREEDMAN, Population Studies Center, University of Michigan
NATHAN KEYFITZ, Department of Sociology, Harvard University
LESLIE KISH, Institute for Social Research, University of Michigan
W. PARKER MAULDIN, Population Division, The Rockefeller Foundation, New York
JANE MENKEN, Office of Population Research, Princeton University
SAMUEL PRESTON, Population Studies Center, University of Pennsylvania
WILLIAM SELTZER, Statistical Office, United Nations
CONRAD TAEUBER, Kennedy Institute, Center for Population Research, Georgetown University
ETIENNE VAN DE WALLE, Population Studies Center, University of Pennsylvania

ROBERT J. LAPHAM, Study Director

NOTE: Members of the committee and its panels and working groups participated in this project in their individual capacities; the listing of their organizational affiliation is for identification purposes only, and the views and designations used in this report are not necessarily those of the organizations mentioned.

Contents

LIST OF TABLES vii

LIST OF FIGURES ix

PREFACE xiii

SUMMARY 1

1 INTRODUCTION 6

2 FERTILITY AND MORTALITY SINCE 1927 11

Infant Mortality by Governorate and Region, 1946-47 to 1975-76 13
Additional Measures of Fertility for Egypt and for Geographic Subdivisions, 1937-76 15

Influence of Marriage Trends on Fertility 18
Voluntary Control of Marital Fertility 21

3 SOURCES OF DATA 24

4 METHODS OF ESTIMATION 28

Infant Mortality 28
Fertility 30
Adult Mortality 34
Projecting the Population 36

APPENDIXES

A Estimation of Infant Mortality 39
B Estimation of Fertility 55
C Estimation of Mortality (Other than Infant and Child Mortality) 70
D Reconstruction of Egyptian Population Projection, 1927-77 89
E Underregistration of Marriages, 1948-60 108
F An Analysis of Underregistration of Births and Deaths in Egypt Based on a CAPMAS Survey, 1974-75 111

GLOSSARY 119

REFERENCES 129

BIBLIOGRAPHY 133

List of Tables

1 Socioeconomic Indicators, 1974-77 9

2 Summary Estimates of Fertility and Mortality, 1927-76 12

3 Estimated Infant Mortality Rates (per thousand) by Region and Governorate, 1946-47, 1960-61, and 1975-76 14

4 Measures and Indexes of Fertility, 1937, 1947, 1960, and 1976 17

5 Proportion of Women Single at Ages 15-19 and 20-24 and Singulate Mean Age at Marriage (SMAM) for Women in 1937, 1947, 1960, and 1976 19

6 Enumerated Population, by Sex, in the 1927-76 Censuses 25

7 Estimated Completeness of Registration of Births and Infant Mortality, 1940s and 1970s 33

A.1 Estimated Completeness of Infant Mortality Rates by Governorate, 1946-47 and 1975-76 49

A.2. Estimated Understatement of Infant Mortality, 1970s 54

B.1 Estimates of Completeness of Birth Registration in the Governorates Based on Reverse Projection of the Census Population Aged 1-4, 1940s and 1970s 57

B.2 Estimates of Completeness of Birth Registration in 1956-59 by Governorate, Based on Reverse Projection of the 1960 Census Population Aged 1-4 58

B.3 Comparison of the Population Estimated from Projected Registered Births and Enumerated in the Census 60

B.4 Measures and Indexes of Fertility by Governorate, 1960 and 1976 64
B.5 Estimates of Underregistration of Births in the 1970s by Major Regions 69

C.1 Measures Used in Reallocation of Excess Deaths at Age 70 and Over 80

D.1 Projected Population by Sex and Five-Year Age Groups at Five-Year Intervals and the 1960 and 1976 Census Dates, 1927 to 1977 92

F.1 Underregistration of Births by Region, 1974-75 112
F.2 Underregistration of Deaths by Region, 1974-75 116
F.3 Underregistration of Infant Deaths by Region, 1974-75 117

List of Figures

1 Summary of Fertility and Mortality Estimates, 1927-76 2
2 Map of Egypt 8
3 Intensity of First Marriages Among Women, 1964-76 20
4 Comparison of the Index of Voluntary Control of Marital Fertility (m) and the Index of Marital Fertility (I_g), Major Regions, 1975-76 22
5 List of Surveys Collecting Primary Data about Fertility, Mortality, or Both 26

A.1 Comparison of Child Mortality Estimates, q(2), Based on the Proportion Dead Among Children Ever Born to Women Married Less than Five Years (Duration Basis) and to Women Aged 20 to 24 (Age Basis), 1947 and 1976 42
A.2 Comparison of the Average Infant Mortality in Health Bureau Areas and Non-Health Bureau Areas of the Governorates, 1946-47 44
A.3 Comparison of the Reported Infant Mortality Rates in Health Bureau Areas and Age- and Duration-Based Estimates of q(1) for the Governorates, 1945-47 46
A.4 Comparison of Age- and Duration-Based Estimates of q(1) to Average Reported Infant Mortality Rates for Urban Areas of Governorates, 1975-76 48
A.5 Comparison of the Completeness of Registered Infant Mortality in 1961 and 1975-76 by Governorate 50
A.6 Infant Mortality Rate Derived from Registration and After Adjustment for Age-Based Estimates of Completeness, 1937-76 52

B.1 Comparison of the Estimated Completeness of Birth Registration in the Governorates in the 1940s and the 1950s 59
B.2 Comparison of the Index of Marital Fertility (I_g) in 1960 and in 1976 for the Governorates 68

C.1 Completeness of Death Registration Estimated by Comparison of Deaths and Population at Age (a) and Over, Males, 1941-42 72
C.2 Cumulative Proportionate Distribution of Population and Deaths at Ages 10 and Over, Males, 1941-42, and for a "South" Model Stable Population 74
C.3 Proportion of Population and Deaths Within the Age Interval 10 to 75 in each Five-Year Age Group Divided by the Corresponding Proportion in a Model Stable Population, Males, 1941-42 75
C.4 Completeness of Death Registration Estimated by Comparison of Deaths and Population at Age (a) and Over, After Reallocation of Excess Deaths at Age 70 and Over, Males, 1941-42 77
C.5 Ratio of the Recorded Proportion of Deaths Over Age 70 to the Estimated Proportion of Deaths Over Age 70, Males and Females, 1937-76 82
C.6 Completeness of Death Registration Estimated by Comparison of Deaths and Population at Age (a) and Over, After Reallocation of Excess Deaths at Age 70 and Over, Males and Females, Selected Years 84
C.7 Estimated Completeness of Death Registration at Age 10+ by Sex, 1937-76 86
C.8 Expectation of Life at Age 10 (e_{10}) from "South" Model Stable Populations as Implied by the Estimated Growth Rate and (1) the Ratio of the Population Aged 10 and Over, (2) the Registered Death Rate at Age 10+, and (3) the Adjusted Death Rate at Age 10+, Males and Females, 1937-76 88

D.1 Ratio of the Enumerated Population to the Projected Population by Five-Year Age Groups, Males, 1927, 1937, 1947, 1960, and 1976 96
D.2 Ratio of the Enumerated Population to the Projected Population by Five-Year Age Groups, Females, 1927, 1937, 1947, 1960, and 1976 97

D.3 Ratio of Males to Females by Age as Enumerated in the Censuses, 1927, 1937, 1947, 1960, and 1976, and in the Projected Population, 1937 99
D.4 Ratio of Cumulated Enumerated Population to Cumulated Projected Population, Males and Females, 1927, 1937, 1947, 1960, and 1976 100
D.5 Cumulated Percent Distribution by Age of the Enumerated and Projected Population, Males and Females, 1937, 1947, 1960, and 1976 104
D.6 Ratio of the Enumerated Population to the Projected Population by Age Groups, Males and Females, 1927, 1937, 1947, 1960, and 1976 106

E.1 "First Marriage Rate" Measured as the Ratio of Registered First Marriages to One-Twentieth the Female Population Aged 10 to 29, 1937-76 109
E.2 Proportion of Registered First Marriages Occurring to Women Under the Age of 20, 1935-75 110

Preface

The Committee on Population and Demography was established in April 1977 by the National Research Council in response to a request by the Agency for International Development (AID) of the U.S. Department of State. It was widely felt by those concerned that the time was ripe for a detailed review of levels and trends of fertility and mortality in the developing world. Although most people in the demographic community agree that mortality has declined in almost all developing countries during the last 30 years, there is uncertainty about more recent changes in mortality in some countries, about current levels of fertility, and about the existence and extent of recent changes in fertility.

In 1963, a Panel on Population Problems of the Committee on Science and Public Policy of the National Academy of Sciences published a report entitled The Growth of World Population. The appointment of that panel and the publication of its report were expressions of the concern then felt by scientists, as well as by other informed persons in many countries, about the implications of population trends. At that time, the most consequential trend was the pronounced and long-continued acceleration in the rate of increase of the population of the world, and especially of the population of the poorer countries. It was estimated in 1963 that the annual rate of increase of the global population had reached 2 percent, a rate that, if continued, would cause the total to double every 35 years. The disproportionate contribution of low-income areas to that acceleration was caused by rapid declines in mortality combined with high fertility that remained almost unchanged: the birth rate was nearly fixed or declined more modestly than the death rate.

Since the earlier report, however, the peak rate of growth in the world's population has apparently been passed. A dramatic decline in the birth rate in almost all the more developed countries has lowered their aggregate annual rate of increase to well below 1 percent, and the peak rate of increase has also apparently been passed in the less-developed parts of the world as a whole. A sharp decline in fertility in many low-income areas has more than offset the generally continued reduction in the death rate, although the rate of population increase remains high in almost all less-developed countries.

The causes of the reductions in fertility--whether they are the effect primarily of such general changes as lowered infant mortality, increasing education, urban rather than rural residence, and improving status of women or of such particular changes as spreading knowledge of and access to efficient methods of contraception or abortion--are strongly debated. There are also divergent views of the appropriate national and international policies on population in the face of these changing trends. The differences in opinion extend to different beliefs and assertions about what the population trends really are in many of the less-developed countries. Because births and deaths are recorded very incompletely in much of Africa, Asia, and Latin America, levels and trends of fertility and mortality must be estimated, and disagreement has arisen in some instances about the most reliable estimates of those levels and trends.

It was to examine these questions that the Committee on Population and Demography was established within the Assembly of Behavioral and Social Sciences of the National Research Council. It was funded initially for a period of three years by AID under Contract No. AID/pha-C-1161. The committee has undertaken three major tasks:

1. To evaluate available evidence and prepare estimates of levels and trends of fertility and mortality in selected developing nations;
2. To improve the technologies for estimating fertility and mortality when only incomplete or inadequate data exist (including techniques of data collection);
3. To evaluate the factors determining the changes in birth rates in less-developed nations.

Given the magnitude of these tasks, the committee decided to concentrate its initial efforts on the first two tasks; it initiated work on the third task in 1979.

The committee approaches the first task through careful assessment, by internal and external comparison, and through analysis, by application of the most reliable methods known, of all the data sources available. Each of the country studies therefore consists of the application of a range of methods to a number of data sets. Best estimates of levels and recent trends are then developed on the grounds of their consistency and plausibility and the robustness of the individual methods from which they were derived.

The committee's second task, refinement of methodology, is seen as a by-product of achieving the first. The application of particular methods to many different data sets from different countries and referring to different time periods will inevitably provide valuable information about the practical functioning of the methods themselves. Particular data sets might also require the development of new methodology or the refinement of existing techniques.

The committee set three criteria for identifying countries to study in detail: that the country have a population large enough to be important in a world view; that there be some uncertainty about levels and recent trends of fertility or mortality; and that sufficient demographic data be available to warrant a detailed study. After a country has been selected for detailed study, the usual procedure is to set up a panel or working group of experts, both nationals of the country and others knowledgeable about the demography and demographic statistics of the country. The role of these panels and working groups, which generally include at least one committee member, is to carry out the comparisons and analyses required. A small staff assists the committee, panels, and working groups in their work.

As of late 1981, 168 population specialists, including 94 from developing countries, have been involved in the work of the committee as members of panels or working groups. The committee, the assembly, and the National Research Council are grateful for the unpaid time and effort these experts have been willing to give.

Each country being studied has a different mix of data sources and different problems with data errors. Therefore, there is no standard pattern for all the reports. However, each report includes a summary of the main findings regarding estimates of fertility and mortality, a description of the data sources available, and a presentation of the analyses that were carried out, classified by type of data analyzed; detailed methodological descriptions are included where necessary in appendixes.

In some of the reports the estimates of fertility and mortality are presented as ranges. The use of a range is deliberate. It indicates that the panel and the committee are confident that the range includes the true value, but have concluded that the evidence does not warrant selecting a single figure as best. The range conveys an important aspect (uncertainty) of the estimation. Ideally, in constructing an average for several populations in each of which estimation is presented as a range, an aggregate range would be calculated (as the population-weighted average of the constituents). The user who selects a single figure from the middle of the range does so at the risk of misleading simplification.

This report, on levels and trends of fertility and mortality in Egypt, is number 9 in a series produced by the committee. In 1978 General Gamal Askar, President of the Central Agency for Public Mobilisation and Statistics (CAPMAS), assisted the Committee on Population and Demography in establishing the Panel on Egypt. The panel met on three occasions to plan the project and to review analyses and findings. The work leading to this report was carried out by panel members, assisted by staffs of CAPMAS and the committee. General Askar and I served as co-chair of the panel. General Askar had primary responsibility for the assembling and initial processing of relevant data for the report, while I had primary responsibility for supervising and carrying out the analysis.

Many readers of this report will know of General Askar's tragically premature death in January 1981. Before he died he provided several pages of comments on the draft manuscript. It is particularly regrettable that he was unable to see the published report since the report owes so much to his interest in the project. General Askar believed that a report summarizing the levels and trends in fertility and mortality in Egypt during recent decades would serve the interests of the Egyptian government and the Egyptian population as long-range plans are made for the economic and social development of the country. The report is a tribute to his interest and support.

The project benefited from much detailed work carried out by many members of the staff at CAPMAS, including preparation of data from the 1976 census and the civil registration system, and assistance in compiling a bibliography that illustrates extensive previous writing on the demography of Egypt. In addition, during the course of this study CAPMAS provided to the panel a series of detailed tabulations from the 1976 census. The data include tabulations of numbers of children ever born and surviving, by mother's age, duration of marriage, and educational attainment. The committee staff entered these data into computer files to produce tabulations that helped the panel assess the nature of Egyptian demographic information and construct estimates of childhood and infant mortality. The latter estimates were in turn used to construct estimates of fertility by means of reverse projection. It is not feasible to reproduce all of these detailed tabulations in this report, but copies can be made available. The tabulations exist by governorate and for urban and rural areas of each governorate.

The committee wishes to express thanks to all members of the panel, who are listed above. As indicated, special thanks are due to the staff of CAPMAS who helped put together necessary tabulations and other information for panel members, including: Saad Zaghloul Amin, Reda El-Sayed Kandil, Farag Sedki Mourad, Amal El Ghamry, Neamat El-Henawy, Noshi Orabi, Raafat Abdel-Hamid, Taher Onyn, Nassef Mohammed Nassef, Mohammed Fetouh, Mostafa Gaafar, and Gihad El-Meikati.

Thanks are also due to the staff of the Committee on Population and Demography, especially to Jane Durch who collaborated with me in much of the detailed analysis. Her careful work on tedious procedures is much appreciated. At an earlier stage Ms. Durch also assisted with necessary computer work, as did Hania Zlotnik of the committee staff. Thanks are also due to the committee's editor, Katherine Miller, who provided much editorial advice, and to Elaine McGarraugh, Assembly editorial assistant, for her careful guidance during the production of this report. The assistance of the committee's staff in typing the draft and final copy of the text and tables is acknowledged with appreciation. Particular thanks are offered to Benita Anderson and Solveig Padilla.

The panel's work included a careful assessment of duration-specific marital fertility in Egypt during the periods 1950-61 and 1966-75. Shafiq El Atoum, professor of statistics at the University of Jordan, assisted with this part of the work program while spending a postdoctoral year of study at Princeton University 1978-79. The panel expresses appreciation to Dr. Atoum for his participation in the project.

Finally, the report has benefited from comments and insights provided by members of the committee and the Assembly of Behavioral and Social Sciences of the National Research Council, and by Ismail Sirageldin, in their reviews of the manuscript.

ANSLEY J. COALE, Chair
Committee on Population and Demography

Summary

In Egypt both fertility and mortality were high until after World War II, but the difference between the birth and death rates was enough to sustain a moderately rapid increase in population. Between 1897 and 1947, according to census counts, the Egyptian population nearly doubled, rising from 9.7 to 19.0 million--an average annual increase of more than 1.3 percent. Beginning in the late 1940s, both infant mortality and the crude death rate began an extensive decline. By 1976, the infant mortality rate was less than half what the rate had been in the 1930s and the expectation of life at birth had risen from about 30 to about 50 years. During the same period, expectation of life at age 10 rose only by about 10 years to about 55 years.

The birth rate fell temporarily during World War II but returned to pre-war levels in the late 1940s. As recently as 1960 and 1961, the birth rate was still an approximate extension of the plateau that characterized the rate before World War II and in the post-war years. Between the early 1960s and the early 1970s, the birth rate declined by some 20 percent and then rose slightly from 1972 to 1977.

The birth rate can be estimated for 1977-79 on the untestable assumption that underregistration of births continued at the same level as for previous years. The birth rate calculated on this assumption continued to rise slightly in 1977 and 1978 to just above 40, and then jumped to 44 in 1979. A 10 percent increase in the number of reported births in one year suggests the possibility that delayed registration may have played a part. Figure 1 shows the approximate values of the birth rate and four measures of mortality for the half century 1927-76. The unusually rich demographic data for Egypt permit the construction of these and other estimates, after adjustments necessitated by the imperfect accuracy of the data.

Most of the 40 million people of Egypt live in the Nile valley and delta which includes three major regions: Cairo and Alexandria, Lower Egypt, and Upper Egypt. Fertility and mortality levels vary among the regions of the country, and some of the differentials have changed in recent decades. In 1946-47 infant mortality was about 213 per thousand live births, with estimated rates of 187 in Cairo and Alexandria, 204 in Lower Egypt, and 259 in Upper Egypt. The rate for Upper Egypt was 39 percent higher than in Cairo and Alexandria, and 27 percent more than in Lower Egypt. By 1975-76 infant mortality had declined by 40 percent or more in all regions, but the rate for Upper Egypt (145) was almost half again as great as in Lower Egypt (99), and a third higher than infant mortality in Cairo and Alexandria (109). Since the end of World War II the gains in infant mortality have been greatest in Lower Egypt.

Fertility rates also vary by region. In 1946-47 the crude birth rate was almost the same in Cairo and Alexandria (47) as in the rest of Egypt (48), but by 1975-76 the crude birth rate ranged from about 32 in Cairo and Alexandria to about 45 in rural Upper Egypt. The total fertility rate, a more accurate measure of fertility levels and trends, was about 6.5 in Egypt in 1937, about 6.3 in 1946-47, up to 6.7 in 1959-60, and down to 5.5 in 1975-76. Regional differences were slight in 1946-47 and somewhat larger in 1959-60 when Cairo and Alexandria had a total fertility rate of 5.9 compared with 6.9 in Lower Egypt and 6.8 in Upper Egypt. By 1975-76, the range was greater and more differentials appeared, for example, 3.9 in Cairo and Alexandria, 5.0 in urban Lower Egypt, 6.0 in rural Lower Egypt, and 6.8 in rural Upper Egypt.

Four other fertility measures are used in this report, including the general fertility rate (200 in 1936-37 declining to 167 in 1975-76), and three indexes of fertility that measure overall fertility, marital fertility and the proportion married among women of childbearing age (I_f, I_g, and I_m). The index of overall fertility, I_f, is the ratio of the number of births occurring in a population to the theoretical maximum number of children that could be produced. The index was just over .50 before and after World War II, and slightly higher in 1959-60, with some regional variation: i.e., .48 in Cairo and Alexandria and about .55 in Lower and Upper Egypt. For 1975-76 I_f showed substantial regional variation, from .31 in Cairo and Alexandria to .55 in rural Upper Egypt, with a level of .45 for Egypt as a whole.

The index of marital fertility, I_g, is the ratio of the number of births occurring to married women to the maximum number of children that married women might have if subject to the maximal fertility rates at each age. For Egypt it was about .68 in 1936-37, slightly higher in 1946-47 and 1959-60, and down to about its previous level of .67 in 1975-76. However, in 1975-76 regional differences were strong: .54 in Cairo and Alexandria and .74 in rural Upper Egypt.

For Egypt as a whole, these more refined measures of fertility suggest a different trend from that of the crude birth rate. Instead of a slight decline, they suggest a rise in fertility in 1960 of 6-8 percent over the 1947 levels. The differences between the crude birth rate and the other measures result from a change in age composition that altered the proportion of women 15-50 within the total population. Between 1947 and 1960 the proportions of women of childbearing age fell by 10 percent because declining infant mortality increased the proportion of children in the population. (After 1960, changes in age composition had little significance for the birth rate as additional reductions in infant mortality were offset by reductions in fertility.) The increase in fertility between 1947 and 1960 was due to slight increases in the proportion married (I_m increased by 2.6 percent) and in marital fertility (I_g increased by 3.2 percent).

The third index, I_m, measures the contribution of marital status to the attainment of maximal overall fertility in a population in which childbearing occurs only among married women (as is the case in Egypt). I_m was about .77 in 1936-37, .75 in 1959-60, and .66 in 1975-76 with a range from .59 in Cairo and Alexandria to .74 in rural Upper Egypt. Thus the proportions of women married were a partial cause of differential fertility among the regions of Egypt.

Between 1960 and 1976 overall fertility (I_f) declined in Egypt by 18 percent. The reduction in the index of the proportion married was greater than the reduction in marital fertility; I_m fell by 12 percent while I_g declined by 6.3 percent. After 1960 there was a marked shift in the frequency of first marriages among younger women. In the age groups 15-19 and 20-24, the proportion single did not change very much between 1937 and 1960, but between 1960 and 1976 substantial increases occurred, from 75 to 83 percent for women 15-19 and from 23 to 39 percent for women 20-24. The singulate mean age at marriage increased by 1.4 years over the years 1960-76. The declines in the frequency of first marriages in the 1960s (the low points were in 1965-69) probably led to the drop in the birth rate in the early 1970s. The increase in the birth rate from 1972 to 1976 was to some degree (perhaps wholly) a consequence of partial recovery from a reduced proportion of married women among younger women of childbearing age.

Thus the reduction in fertility in Egypt over 1960-76 was caused by both later marriage and a small decrease in marital fertility. As is typical in many developing nations, the declines began sooner and were larger in large metropolitan areas. Cairo and Alexandria had lower proportions of married women as early as 1947. Sharp declines occurred in these two cities over 1960-76 in the proportions married (17 percent) and in marital fertility (20 percent). By comparison, during the 1960-76 period, in Lower Egypt the decline in marital fertility was about 5 percent, and in Upper Egypt there was a negligible rise of 1.3 percent. These results are supported by independent measures of the effects of voluntary control of marital fertility in the major regions of Egypt.

1 Introduction

The more than 40 million people of Egypt live crowded onto a tiny fraction of the country's one million square kilometers (386,000 square miles). Set in the northeast corner of Africa, Egypt is roughly 95 percent desert, interrupted only by the country's lifeline, the Nile River, which stretches 1,000 miles from south to north. More than 95 percent of the population lives in the valley along the Nile and in the fertile broad delta that the river has created over millennia. Most of the country is subject to the hot summers, cool winters, and limited rainfall of the desert; only the northernmost areas on the Mediterranean have a more temperate climate, with higher humidity and rainfall.

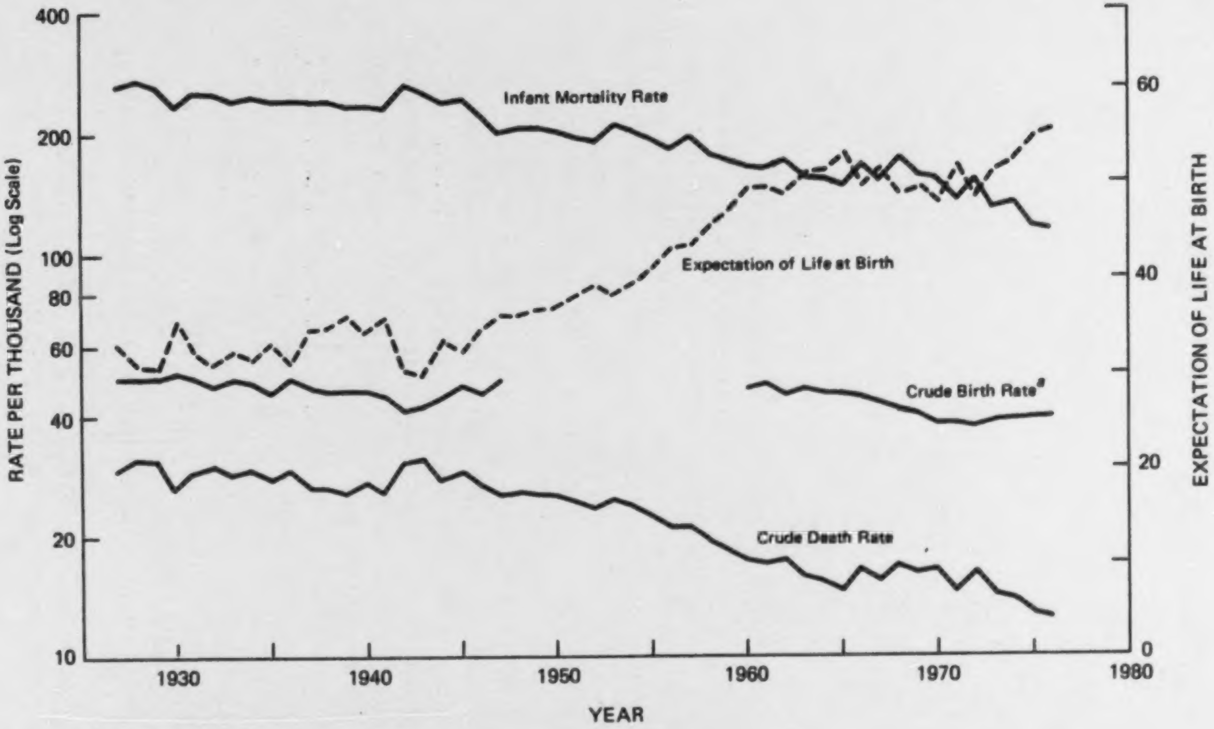
The country's northern boundary is the Mediterranean Sea; Libya lies to the west and Sudan to the south. The Suez Canal, which connects the Mediterranean and the Gulf of Suez, separates the Sinai Peninsula from the main land mass of Egypt. To the east, on the Sinai peninsula, is a short border with Israel. The remainder of the eastern border is coastline along the Gulf of Suez, the Gulf of Aqaba, and the Red Sea.

Egypt's 25 administrative units are called governorates. Two of the most populous are the urban governorates of Cairo and Alexandria. In 1976, Cairo had over 5 million inhabitants and the city of Alexandria had 2.3 million; thus about a fifth of the population resides in these two large metropolises. (The Cairo metropolis is in fact larger because Greater Cairo, which includes part of Giza Governorate across the Nile, had about 8 million people in 1976.) Suez and Port Said are smaller urban governorates on the Suez Canal. At the other extreme are the four frontier governorates, in the Sinai Peninsula and the desert areas east and west of the Nile

Valley, which are inhabited by less than 1 percent of the population. The 17 other governorates are grouped into the two traditional regions of Upper and Lower Egypt. Nine governorates lying in the north in the Nile delta or along the Suez Canal comprise Lower Egypt (Behera, Dakahlia, Damietta, Gharbia, Ismailia, Kafr-el-Sheik, Kalyubia, Menoufia, and Sharkia), while the remaining eight, south of Cairo, constitute Upper Egypt (Assyiut, Aswan, Beni Suef, Fayoum, Giza, Kena, Minya, and Souhag). (See Figure 2.)

Aside from the desert, the dominant feature of life and geography in Egypt is the Nile River. Since ancient times the river has been the principal source of water necessary for agriculture and thus has always defined the population centers of the country. The second longest river in the world, the Nile originates in Uganda and Ethiopia and flows north from these headwaters through Sudan before reaching Egypt's southern border. There the river widens into Lake Nasser, created in 1975 by the completion of the Aswan High Dam. From there, it flows generally northward until it reaches the Mediterranean. In southern Egypt, the river flows through a narrow valley which gradually widens farther north. This southern section of Egypt above Cairo consists of a strip of fertile land often only a mile or two wide along the Nile, surrounded by arid desert. At Cairo, about 100 miles from the sea, the river fans out through a wide, fertile delta.

Although the amount of cultivable land in Egypt is extremely limited, agriculture has been and continues to be a major aspect of the Egyptian economy, employing about half the labor force and contributing about a quarter of the gross domestic product. High-quality, long-staple cotton is a main commercial crop, and its export provides a major source of income for the country. Some food crops are also grown for export, but Egypt must import foodstuffs to meet domestic needs. Agriculture in Egypt depends on irrigation with water drawn from the Nile. Historically the annual flooding of the Nile also provided silt, helping to renew the soil. The Aswan High Dam, in addition to providing cheap hydroelectric power, has made it possible to control the annual flooding and to provide a more steady year-round flow of water for irrigation. But the dam also blocks most of the silt which the Nile carries. The long-term effects of this change are not yet clear.



[a]Birth rates were not estimated for 1948-1959.

FIGURE 1 Summary of Fertility and Mortality Estimates, 1927-76: Egypt

Source: Table 2.

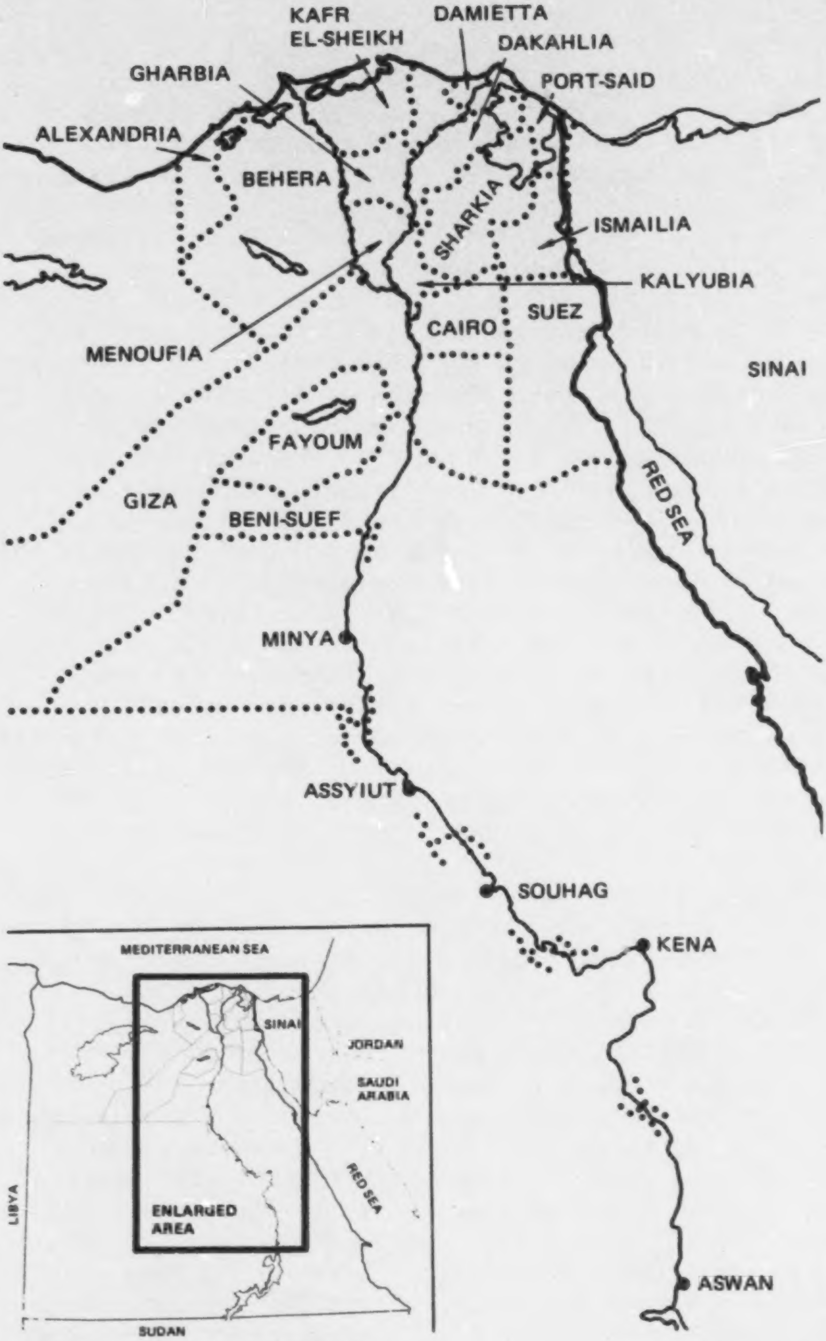

KAFR EL-SHEIKH
DAMIETTA
DAKAHLIA
GHARBIA
PORT-SAID
ALEXANDRIA
BEHERA
SHARKIA
ISMAILIA
KALYUBIA
MENOUFIA
CAIRO
SUEZ
SINAI
FAYOUM
RED SEA
GIZA
BENI-SUEF
MINYA
ASSYIUT
SOUHAG
KENA
ASWAN
MEDITERRANEAN SEA
SINAI
JORDAN
SAUDI ARABIA
RED SEA
LIBYA
ENLARGED AREA
SUDAN

FIGURE 2 Map of Egypt

Table 1 presents several recent socioeconomic indicators for Egypt. On the whole the urban governorates, especially Cairo and Alexandria, are the most advanced in terms of such factors as literacy, occupational structure, and social services (ranging from electrification and running water to doctors and hospitals). Lower Egypt fares less well than the metropolitan areas, but Upper Egypt has experienced the least socioeconomic development.

More than 5,000 years ago, Egypt was the site of one of the major civilizations in world history. After centuries of native rule, the country fell under the influence of a succession of foreign powers, most notably in the last several centuries the Ottoman Turks and, beginning in the nineteenth century, the British. Egypt obtained independence from Great Britain in 1922, and in 1953 a republic was established. Gamal Abdul Nasser was elected and served as president until his death in 1970, when Anwar Sadat became president. Hosni Mubarak became the third president of Egypt following the death of Sadat in 1981.

Today Egypt is basically an Islamic society. Islam was brought to the country in the seventh century as the Arabs established control of most of North Africa. About

TABLE 1 Socioeconomic Indicators, 1974-77: Egypt

Gross national product per capita, 1977[a]	US $320
Percent of gross domestic product from agriculture, 1977[a]	28.0
Percent of labor force in agriculture, 1977[a]	51.0
Percent of labor force that are unpaid family workers, 1974[b]	18.6
Percent of population aged 10 and older that is literate, 1976[c]	43.5
Percent of households with access to purified water, 1976[c]	74.8
Percent of population urban, 1976[c]	43.9
Density of inhabited area (population per sq. mile), 1976[b]	1,881
Dependency ratio (ratio of population under 15 or 65 and over to the population aged 15-64), 1976[c]	.771
Population per physician, 1976[a]	1,190

Sources:

[a] *World Development Report, 1979*. World Bank (1979).
[b] *Population and Development: A Study on the Population Increase and Its Challenge to Development in Egypt*. Egypt [CAPMAS] (1978).
[c] *Preliminary Results of the General Population and Housing Census, 22/23 November 1976*. Egypt [CAPMAS] (n.d.b).

6 percent of the population are Christians, most of whom belong to the Coptic Church. This Christian minority is concentrated in Cairo and in the governorates of Minya, Assyiut, and Souhag in Upper Egypt.

2 Fertility and Mortality Since 1927

The first use of the estimates we have constructed (or assembled) is to provide an outline of the general course of Egyptian fertility and mortality during the past half century. Table 2 presents approximate values of the birth rate, the death rate, the infant mortality rate, and the expectation of life at birth and at age 10 for this period. Since the major change in mortality, and whatever significant decline there has been in fertility, occurred since the late 1940s, the second use of our estimates is to show the course of fertility and mortality in more detail during the last three decades. Detail is increased in two ways: information is presented about geographically defined subsets of the Egyptian population, and measures of fertility more informative than the crude birth rate are introduced. Estimates of mortality above age 5, however, have not been made for regions or governorates.

The tabulation of reported vital events in Egypt provides the basis for estimates of the crude birth rate through 1979 and of the infant mortality rate for 1977. At some risk of error the estimates for these most recent years are constructed by applying estimates of underregistration developed in this report to the numbers of reported events, and by projecting the 1976 population forward to 1979. The resulting birth rate estimates are 40.3 for 1977, 40.4 for 1978 and 44.3 for 1979. The big jump in 1979 results from a large increase in the number of reported births: 1,681,938 in 1979 compared with 1,490,624 in 1978 and 1,460,620 in 1977. The estimated infant mortality rate for 1977 is 113 per thousand live births. Table 2 shows the estimates only through 1976 because more detailed analysis, including use of data from the 1976 census, is possible through that date. The

TABLE 2 Summary Estimates of Fertility and Mortality, 1927-76: Egypt

Year	Crude Birth Rate[a]	Crude Death Rate[b]	Infant Mortality Rate	Expectation of Life at Birth	Expectation of Life at Age 10[c]
1927	49.4	29.3	264	33.0	45.7
1928	49.0	31.3	278	30.7	43.7
1929	49.6	31.0	266	30.6	42.4
1930	51.0	26.6	239	35.4	46.5
1931	49.9	28.9	255	32.5	44.1
1932	47.7	30.0	253	31.0	41.7
1933	49.1	28.6	244	32.3	42.8
1934	48.0	29.3	250	31.5	42.2
1935	45.9	27.7	242	33.2	43.8
1936	49.4	29.1	244	31.3	41.4
1937	47.0	26.6	243	34.5	45.7
1938	46.0	26.5	244	34.8	46.3
1939	46.4	25.6	237	36.0	47.1
1940	46.2	27.2	238	34.4	46.3
1941	45.1	25.9	234	35.7	46.1
1942	41.0	30.7	264	30.5	42.0
1943	42.2	31.1	257	29.8	40.4
1944	44.3	27.9	241	33.4	44.0
1945	47.9	29.0	246	32.3	42.9
1946	45.5	27.0	223	34.4	43.6
1947	49.1	25.5	201	36.1	43.7
1948	--	25.8	209	36.2	44.7
1949	--	25.6	209	36.7	45.3
1950	--	25.4	204	37.0	45.2
1951	--	24.8	199	37.9	45.9
1952	--	23.9	193	39.1	46.8
1953	--	24.9	213	38.2	47.7
1954	--	24.0	205	39.3	48.3
1955	--	22.8	195	40.9	49.2
1956	--	21.1	183	43.1	50.7
1957	--	21.2	196	43.4	52.3
1958	--	19.4	179	45.9	53.6
1959	--	18.3	171	47.3	54.4
1960	46.6	17.4	168	49.2	56.3
1961	47.7	17.1	166	49.4	56.4
1962	45.1	17.4	171	48.9	56.4
1963	46.5	16.0	157	51.0	57.2
1964	45.8	15.6	155	51.4	57.5
1965	45.4	14.7	149	53.1	58.8
1966	44.6	16.5	168	49.7	56.9
1967	42.8	15.4	153	51.4	57.2
1968	41.7	16.9	173	48.8	56.4
1969	40.2	16.1	157	49.4	55.4
1970	38.2	16.4	153	48.1	53.4
1971	38.2	14.4	136	51.8	55.8
1972	37.0	16.1	153	48.4	53.7
1973	38.4	14.3	130	51.3	54.5
1974	38.6	13.9	133	52.4	56.1
1975	39.0	12.8	118	54.9	57.0
1976	39.5	12.6	116	55.4	57.4

TABLE 2 (continued)

[a] Insufficient evidence for estimating the extent of underregistration of births in the period 1948-59.

[b] The crude death rate is determined by choosing a model life table up to age 5 that is matched with the infant mortality rate and a second model life table for above age 5 that is matched with the expectation of life at age 10 (e_{10}). The age specific mortality rates obtained from these life tables are applied to the projected age distribution for each year to obtain the number of deaths, and the projected population is used as the denominator to calculate the crude death rate. These crude death rates, therefore, are not directly comparable with crude death rates calculated from registration data.

[c] Expectation of life at age 10 (e_{10}) is an unweighted average of e_{10} for males and females from adjusted death rates (see Appendix C).

above estimates for years beyond 1976 may be subject to changed reporting practices. For example, the completeness of birth registration may have increased beyond the 96.4 percent level estimated for the period prior to 1976, the extent and patterns of delayed registration may have changed, and shifts in marriage patterns may have affected the crude birth rate. Therefore, the rates for years after 1976 should be used with caution.

INFANT MORTALITY BY GOVERNORATE AND REGION, 1946-47 to 1975-76

We were unable to calculate satisfactory corrections for completeness of registration of non-infant deaths by governorate, hence this more detailed discussion is limited to infant mortality. Table 3 shows estimated infant mortality rates for governorates and for three major regions of Egypt in 1946-47, 1960-61, and 1975-76. The "regions" are the combined urban governorates of Cairo and Alexandria; Lower Egypt, lying between Cairo and the Mediterranean, and encompassing the delta of the Nile; and Upper Egypt, the southern section of Egypt above Cairo. Cairo and Alexandria had the lowest infant mortality rate (IMR) of the three regions in 1946-47, but were overtaken by Lower Egypt in 1960-61 and 1975-76. In all regions the proportionate decline in IMR from 1946-47 to 1975-76 was more than 40 percent. Throughout the period, infant mortality in Upper Egypt was consistently higher than in the other regions. In 1960-61 Upper Egypt infant mortality exceeded the rates in 1946-47 in the rest of Egypt; in 1975-76 infant mortality in Upper Egypt had barely attained the level reached 15 years earlier in the metropolitan populations and in Lower Egypt.

TABLE 3 Estimated Infant Mortality Rates (per thousand) by Region and Governorate, 1946-47, 1960-61, and 1975-76: Egypt

Region and Governorate	1946-47	1960-61	1975-76	1975-76	
				Urban	Rural
Cairo and Alexandria	187.3	149.1	108.7	108.7	--
Cairo	186.4	151.0	113.7	113.7	--
Alexandria	189.3	142.3	98.6	98.6	--
Lower Egypt	203.6	147.2	98.6	95.0	99.7
Damietta	134.0[a]	89.8	93.9	80.0	96.6
Dakahlia	206.2	149.5	90.8	70.8	95.7
Sharkia	207.1	131.4	105.7	90.3	109.1
Kalyubia	244.6	211.4	123.5	127.9	119.6
Kafr-el-Sheik	-- [b]	108.2	83.1	74.0	85.5
Gharbia	190.1	147.4	92.6	90.1	93.6
Menoufia	228.7	174.7	110.8	94.8	113.6
Behera	169.0	124.8	87.7	84.6	88.4
Ismailia	-- [b]	-- [b]	93.3	104.7	84.2
Upper Egypt	259.0	225.0	144.9	126.9	152.6
Giza	265.8	207.3	122.4	117.4	127.4
Beni Suef	284.9	263.2	156.1	135.0	162.6
Fayoum	303.4	196.6	151.8	142.8	154.2
Minya	287.9	237.9	162.2	136.5	168.5
Assyiut	259.5	224.4	148.6	126.8	154.9
Souhag	228.1	219.0	134.1	122.1	137.8
Kena	237.0	237.8	153.1	128.4	160.7
Aswan	210.0	204.1	148.2	142.4	153.1
Egypt	213.4	168.4	117.5	111.0	122.8

[a] Damietta was not included in Lower Egypt in 1946-47.
[b] Not a separate governorate at that date.

In 1975-76, urban infant mortality was lower than rural in every governorate except Kalyubia and Ismailia. Much of the urban population of Kalyubia resides in the Cairo metropolitan area; the urban IMR in Kalyubia is slightly higher than IMR in urban Giza (also part of the Cairo metropolitan area); the rate in urban Giza in turn slightly exceeds the rate in Cairo. The rural part of Kalyubia is in Lower Egypt. The rural areas of the other governorates in Lower Egypt have lower infant mortality rates than Cairo. In other words, the fact that Kalyubia's urban population consists mostly of the highest infant mortality population in the metropolitan area may account for the higher urban than rural infant mortality rate in this governorate.

There are three distinct geographic clusters of infant mortality rates in 1975-76 in the rural populations of the governorates. In six governorates near the Mediterranean (Ismailia, Damietta, Dakahlia, Kafr-el-Sheik, Behera, and Gharbia) the rural infant mortality rate is less than 100 (per thousand live births); in four governorates in the delta or along the Nile near Cairo (Sharkia, Menoufia, Kalyubia, and Giza) rural IMR lies between 109 and 127; in the seven governorates farther up the Nile (Souhag, Aswan, Fayoum, Assyiut, Kena, Beni-Suef, and Minya) the rural infant mortality rate lies between 138 and 168.

ADDITIONAL MEASURES OF FERTILITY FOR EGYPT AND FOR GEOGRAPHIC SUBDIVISIONS, 1937-76

The crude birth rate has well-known limitations as a measure of trends and differences in fertility, the most troublesome limitation being the strong influence of the composition of the population by age and sex. For example, an area may have a high birth rate because young married couples have migrated there. Also, within a given population the birth rate falls when mortality is reduced, even if women of childbearing age have births at an undiminished rate, because a reduction in mortality typically reduces the ratio of the number of women aged 15 to 50 to the total population. In portraying changes in fertility in Egypt it is therefore convenient to employ measures of fertility that are partly or wholly independent of differences in age composition. It is possible to construct such measures and indices for years in which there was a census that provides information on the composition of the population by age, sex and marital status.

The fertility measures we have employed are: (1) the general fertility rate, defined as the rate at which women aged 15 to 50 bear children. It equals the crude birth rate divided by the ratio of the number of women aged 15-50 to the total population; (2) the total fertility rate, defined as the number of children that would be born per woman in a hypothetical cohort subject, from age 15 to 50, to the age-specific rates of childbearing in the population in question; and (3) three indexes of fertility (I_f, I_g, and I_m) that measure overall fertility, marital fertility, and the proportion married among women of childbearing age. The index of overall fertility, I_f, is the ratio of the number of births occurring in a population to the maximum number that might occur, if women at each age experienced the highest rates of marital childbearing on reliable record for a population. The index of marital fertility, I_g, is the ratio of the number of births occurring to married women to the maximum number married women might have if subject to maximal fertility rates at each age. The index of proportion married, I_m, is a fertility-weighted index that measures the contribution of marital status to the attainment of maximal overall fertility in a population in which childbearing occurs only among married women (as is true in Egypt). The indexes strictly of fertility (I_f and I_g) lie between 0 and 1--a value of 1 would imply attainment of maximal fertility, and 0 implies no births at all. The index of marriage (I_m) falls within the same range: it is 1 if all women 15 to 50 are married, and 0 if all are single, widowed, or divorced. Because in no recorded instances does early and universal marriage coincide with maximal marital fertility, the highest observed values of I_f are about 0.70. The highest observed value of I_g is about 1.0 and of I_m, slightly above 0.90. When fertility among the non-married is negligible, the three indexes are related by the identity $I_f = I_m \cdot I_g$. Overall fertility is thus factored into two components: the proportion married and marital fertility (see Coale, 1965 and 1970, for a fuller definition of the indexes).

All of these measures and indexes are presented in Table 4 for Egypt at the time of the censuses of 1937, 1947, 1960, and 1976, and for selected geographic subdivisions at the three later time periods. No data are presented on the frontier areas, and, except in some of the methodological comparisons, data for Suez and Port Said are also omitted. For the period before 1961 this exclusion applies to the urban governorates other than Cairo and Alexandria.

For Egypt as a whole, the more refined measures of fertility for women of childbearing age (the general fertility rate, the total fertility rate, and I_f) follow a somewhat different course than does the crude birth rate--the reason for the difference being the change in age composition that altered the proportion of women 15-50 within the total population. From 1937 to

1947 the change was modest (probably within the margin of error caused by the changing degree of age misstatement), but between 1947 and 1960 the proportion of women of childbearing age fell by nearly 10 percent as declining infant mortality increased the proportion of children in the population. Still greater reductions in infant mortality after 1960 were offset by reductions in fertility; women 15-50 were a slightly higher fraction of the population in 1976 than in 1960.

The estimates of the general fertility rate, total fertility rate and I_f for Egypt in 1960 show a rise of 6 to 8 percent over the levels estimated for 1947. Because of the margin of error in our estimation of completeness of enumeration, the true extent of the increase is uncertain, but since we have chosen conservative estimates of the extent of underregistration in 1960, there is little doubt that an increase occurred. The increase is the joint result of a slight rise in both the proportion married (I_m increased by 2.6 percent), and marital fertility (I_g increased by 3.2 percent). Similar increases in marital fertility in a period before the widespread adoption of contraception or abortion have been noted in a number of developing countries (Coale et al., 1979; Coale et al., 1980).

Influence of Marriage Trends on Fertility

From 1960 to 1976, overall fertility fell by 18 percent. The reduction in the index of the proportion married was greater than the reduction in marital fertility; I_m fell by 12 percent, while I_g fell by 6.3 percent. The reduction in I_m must have been the result of a marked change after 1960 in the frequency of first marriages among younger women. Table 5 shows the proportion single among women at ages 15-19 and 20-24 from 1937 to 1976, together with the singulate mean age at first marriage (SMAM), calculated from proportions single from age 15 to 50 in each census. (The singulate mean age at first marriage is the average age at first marriage that would be experienced by a hypothetical group of persons if, in moving from age 15 to 50, the group had the proportions single observed in the census.) Note the slight changes in proportions single and in SMAM from 1937 to 1960, and the significant changes between 1960 and 1976.

In Figure 3 a measure of what might be called the intensity of first marriages is shown from 1964 to 1976.

TABLE 5 Proportion of Women Single at Ages 15-19 and 20-24 and Singulate Mean Age at Marriage (SMAM) for Women in 1937, 1947, 1960, and 1976: Egypt

Proportion Single	1937	1947	1960	1976
15-19	.752	.736[a]	.746[b]	.833
20-24	.197[c]	.200[b]	.229	.389
SMAM	20.04	20.12	20.26	21.65

[a] After adjustment for "unknown". "Unknown" assumed to be 0.5 percent of the total; other "unknown" taken as single.
[b] After adjustment for "unknown": of 1,040,286 women aged 15-19, 776,500 were estimated to be single; 2,300 were assumed to belong in the category "unknown."
[c] Estimated from marital status distribution by ten-year age groups.

This measure is the number of first marriages divided by the approximate number of women at the mean age of first marriage--about age 20 in Egypt. The number at age 20 is approximated by the average number of women in a 20-year age-span centered on age 20--one-twentieth of the number from 10 to 29. When almost all women marry, generally the case in Egypt, the "intensity" of first marriages should average slightly below 1.0.

A rise in mean age at first marriage of one year means, crudely, that one calendar year's first marriages are missing over the period during which the change in mean age takes place. (This relation can be understood by picturing a hypothetical population in which all first marriages take place at the mean age, say 20. In year t, the usual first marriages take place with brides aged 20. In year t + 1, the mean age moves up to 21, but no marriages take place until t + 2, since the cohort aged 21 in t + 1 has already married at 20. From t + 2 on, marriages occur in normal numbers at the older age, but one year's marriages have been lost.) Thus between 1960 and 1976, when SMAM increased by 1.4 years, the rate of first marriage must have decreased, as can be seen in the low points from 1965 to 1969 in Figure 3. It seems probable that the low point in the birth rate sequence in the early 1970s (seen in Table 2 and Figure 2) reflected this cumulative deficit in the number of recently married couples. Were it possible to calculate I_m for 1970, it

TABLE 4 Measures and Indexes of Fertility, 1937, 1947, 1960, 1976: Egypt

	Crude Birth Rate	General Fertility Rate	Total Fertility Rate	Index of Overall Fertility I_f	Index of Marital Fertility I_g	Index of Proportion Married I_m	Women 15-49 Divided by Total Population
1936-37							
Egypt	48.2	198.8	6.45	.520	.679	.766	.243
1946-47							
Egypt	47.9	191.7	6.31	.509	.694	.734	.250
Cairo and Alexandria	47.5	188.0	6.04	.487	.711	.684	.253
Rest of Egypt	48.0	192.7	6.36	.513	.690	.744	.249
1959-60							
Egypt	46.3	204.5	6.71	.541	.716	.753	.226
Cairo and Alexandria	41.3	184.7	5.90	.476	.667	.703	.224
Lower Egypt	46.2	208.1	6.88	.555	.726	.764	.222
Upper Egypt	47.8	205.9	6.78	.547	.714	.767	.232
1975-76							
Egypt	39.2	167.3	5.52	.445	.671	.663	.234
Cairo and Alexandria	31.5	121.2	3.89	.314	.535	.587	.260
Lower Egypt	38.6	169.6	5.70	.460	.692	.656	.228
Rural	39.3	177.9	5.99	.483	.703	.687	.221
Urban	36.6	149.1	5.01	.404	.659	.614	.246
Upper Egypt	44.1	193.7	6.40	.516	.725	.712	.228
Rural	45.5	204.5	6.81	.549	.739	.743	.223
Urban	40.7	169.7	5.56	.448	.692	.648	.240

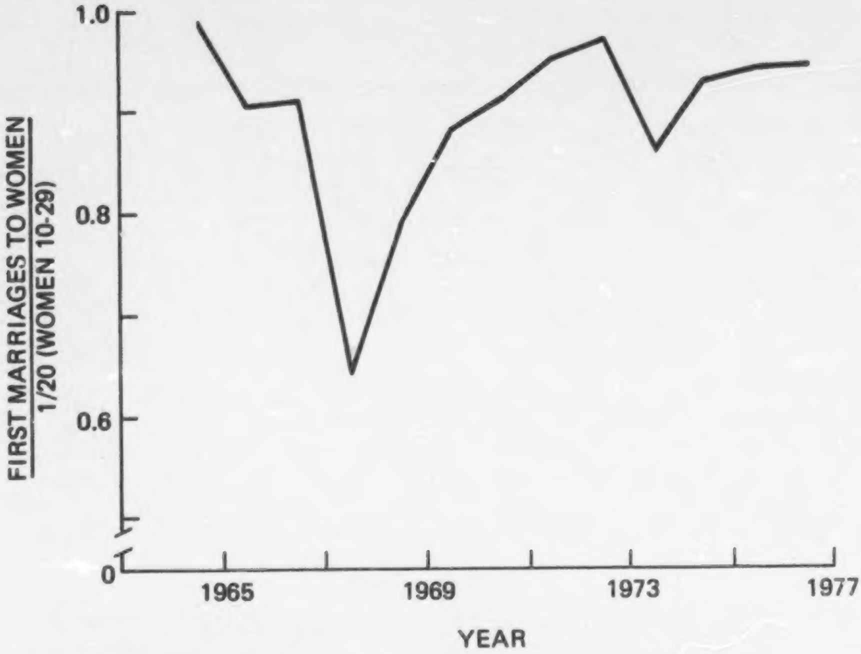


FIGURE 3 Intensity of First Marriages Among Women, 1964-76: Egypt

would doubtless have been still lower than in 1976. The recovery of the birth rate after 1972 was to a large extent, if not wholly, a consequence of partial recovery from a greatly reduced fraction married among younger women of childbearing age.

The regional measures of fertility in Table 4 show that in 1947 and 1960 Cairo and Alexandria had lower proportions married than the rest of the country; I_m there was about 92 percent of I_m in the remainder of Egypt. In 1947 marital fertility in the metropolitan areas was at least as high as in the rest of Egypt (an I_g of 0.711 compared to 0.690), but by 1960 marital fertility in Cairo and Alexandria was only about 93 percent as high as in Upper and Lower Egypt combined. All three indexes for the latter two regions were very nearly the same--indeed indistinguishable given the margin of error in adjusting the original data.

Between 1960 and 1976, the decline in overall fertility and in both of its components (marital fertility and proportions married) was greatest for Cairo and Alexandria. In 1976 urban Lower Egypt reached an

I_m almost as low as Cairo and Alexandria, but its I_g was substantially higher than in the two major cities. Urban Upper Egypt had a lower I_m and I_g than rural Upper Egypt, but not much lower than rural Lower Egypt. Note that in 1976 the I_g in rural Upper Egypt was virtually the same as that in Upper Egypt in 1960, and I_m was only slightly lower.

In sum, we can see that the reduction in fertility in Egypt has been caused both by later marriage (a reduction in the effective incidence of nuptiality) and by a fall in marital fertility. Lower proportions married characterized Cairo and Alexandria as early as 1947. Between 1960 and 1976 the reduction in I_m in these cities was particularly sharp compared to other areas, although other urban areas in Lower Egypt, and to some extent in Upper Egypt, had also attained low I_m. The decline in marital fertility was large (20 percent between 1960 and 1976) only in the large cities. In Lower Egypt the decline in marital fertility was about 5 percent, and in Upper Egypt there was a negligible rise of 1.3 percent.

Voluntary Control of Marital Fertility

As a final comment on recent fertility in Egypt, we note evidence of the effect of voluntary control of marital fertility in the major regions, revealed by data collected in the National Fertility Survey conducted in 1974 and 1975. The survey collected retrospective fertility histories from a sample of more than 12,000 currently married women. Mahmoud S. A. Issa (1980) has calculated age-specific marital fertility rates for each region from data on births during the preceding five years to women who were continuously married during the five years before the survey. He has also calculated an index of the degree of departure of the age structure of marital fertility from the pattern typical of populations in which there is no voluntary control of marital fertility (Coale, 1971; Coale and Trussell, 1974, 1978). This index (m) is zero when marital fertility follows the typical pattern of "natural" fertility; it reaches values of 2.0 or more in populations in which the majority of couples use contraceptives or abortion to limit the total number of births to a very small number.

In Figure 4, the value of m (the degree of control indicated by the age structure, not the level, of marital

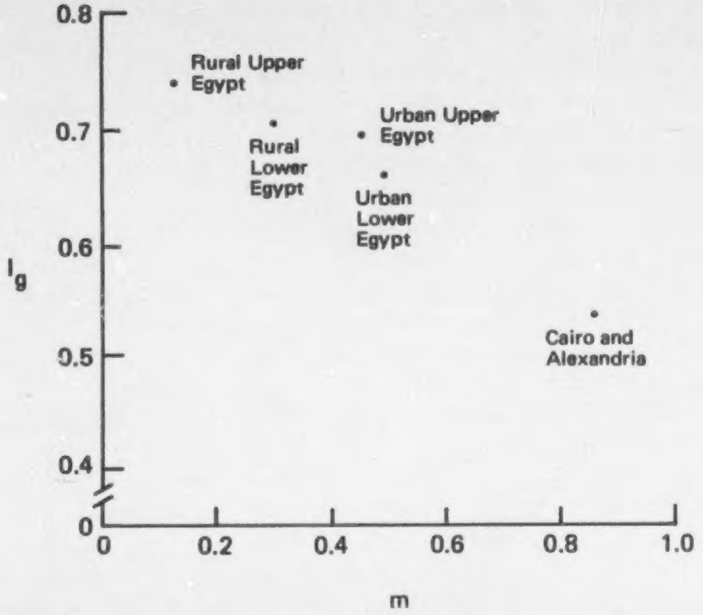


FIGURE 4 Comparison of the Index of Voluntary Control of Marital Fertility (m) and the Index of Marital Fertility (I_g), Major Regions, 1975-76: Egypt

fertility) is compared with our calculations of I_g. The close agreement gains significance from the complete independence of the two measures. One measure (I_g) is based on registered births corrected for underregistration, and the census count of married women. The other measure (m) is based on the rate at which marital fertility falls with age of women, as revealed in retrospective fertility histories collected in a sample survey. The story is the same: marital fertility is lowest (and most strongly controlled) in Cairo and Alexandria, and progressively higher (and less controlled) in urban Lower Egypt, urban Upper Egypt, rural Lower Egypt, and rural Upper Egypt. In rural Upper Egypt, m has a value (0.125) within a range of departure from zero of ± 0.20 found in populations in which voluntary control appears to be absent.

Preliminary findings from two recent surveys also substantiate regional variation in the control of marital fertility. Reported contraceptive prevalence rates (the proportion of currently married women aged 15-49 using contraception) in 1979 and 1980 are listed below (Sayed, 1981; Egypt [CAPMAS], 1981):

	Contraceptive Prevalence Rates		
	Total Urban (percent)	Total Rural (percent)	Total Egypt (percent)
Rural Fertility Survey 1979		12	
Egyptian Fertility Survey 1980	40	15	24

Prevalence rates follow the same regional pattern as the m values based on the 1974-75 survey. Marital fertility control, reported in the 1980 Egyptian Fertility Survey, is greatest in Cairo and Alexandria (43 percent prevalence), only slightly less in urban Lower Egypt (41 percent), and progressively less in urban Upper Egypt (33 percent), rural Lower Egypt (18 percent), and rural Upper Egypt (4 percent). The principal method of contraception in Egypt is the pill, accounting for about two thirds of total prevalence in 1980.

3 Sources of Data

Under ideal conditions of availability and accuracy of demographic data, levels and trends of fertility and mortality are calculated from a combination of registered births classified by age of mother, registered deaths classified by age of the decedent, and data on the number of persons by age and sex derived from a series of accurate population censuses. In most developing countries, demographic data of the ideal sort do not exist. At best, the official figures can be used only after correcting for omissions, misstatement of age, and the like. More often, registration of births and deaths is so meager that levels and trends must be estimated by indirect procedures from data derived solely from censuses and demographic surveys.

Demographic data in Egypt are unusually rich, although imperfectly accurate. The data include a series of 10 censuses (the first in 1882) among which have been used, in some degree, those of 1927, 1937, 1947, 1960, and 1976. These censuses provide a count of persons classified by their reported age, by sex, and by marital status. Table 6 lists the total population, by sex, enumerated in these five censuses. Some of the censuses list the number of children ever born (1947, 1960, and 1976), and the number of living children (1947 and 1976) for women in different intervals of age and of marriage duration.

A feature of Egyptian population data even more unusual for a developing country than a long series of censuses is the existence of recorded information on registered deaths classified by age and sex, registered births (classified by age and duration of the marriage of the mother, as well as certain characteristics of the father), registered marriages (classified in detail

TABLE 6 Enumerated Population, by Sex, in the 1927-76 Censuses: Egypt

	Population (thousands)		
Census	Total	Males	Females
1927	14,178	7,058	7,120
1937	15,921	7,967	7,954
1947	18,967	9,392	9,575
1960	26,085	13,118	12,967
1976	36,656	18,699	17,957

Source: Egypt [CAPMAS] (1979:10).

concerning age and previous marital status of bride and groom), and registered divorces (classified by duration of marriage and other categories).

In addition to population censuses and registration of vital statistics, there have been a number of special surveys that have collected primary data about fertility, mortality, or both from samples of the Egyptian population (see Figure 5). Two of these surveys covered large nationwide samples--the National Fertility Survey conducted in 1974 and 1975, and a survey conducted in 1980 in collaboration with the World Fertility Survey. A second large survey in 1979 under the auspices of the National Family Planning Board covered a sample of the rural population only. Data from the surveys taken in 1979 and 1980 were not tabulated and processed in time for inclusion in this report, but we have used data from the 1974-75 National Fertility Survey as a check on our regional estimates of infant mortality and marital fertility, estimates derived from a combination of census and registration data.

Until 1961, registration of births and deaths was the responsibility of medical officials within those areas in which there were Health Bureaus, and of tax collectors in the remainder of the country. Special information (order of birth, age and duration of marriage of the mother, and cause of death) was recorded only in the Health Bureau areas. After a reorganization of vital statistics registration in the 1960s, uniform registration

FIGURE 5 List of Surveys Collecting Primary Data about Fertility, Mortality, or Both: Egypt

1965-1966	Rural Vital Rates Survey in Lower Egypt
1966	Census of Population (tabulated on a sample basis)
1974-1975	The National Fertility Sample Survey Project in Egypt
1974-1975	The Vital Events Sample Survey, 1974-1975
1979	National Family Planning Board Rural Population Survey
1980	Egyptian Fertility Survey (EFS)--associated with the World Fertility Survey program

procedures were followed in recording vital events in all areas, with or without Health Bureaus.

The existence of an extended series of censuses and the registration of births, deaths, marriages, and divorces do not imply that Egyptian fertility, mortality, and nuptiality can be delineated readily by an appropriate combination of numbers of registered events and numbers of persons (or person years) derived from censuses to obtain standard rates and measures. Completeness of coverage of the censuses has been imperfect in varying degrees, both for the total population and for persons of each sex at different ages. There is persistent evidence revealing incompleteness of registration of births and deaths in Egypt; for example, birth and death rates calculated from registered events in areas served by Health Bureaus were consistently higher than those in other parts of the same governorates.

Another reason why indexes of fertility and mortality cannot be calculated by routine procedures is the inaccurate recording of age, duration of marriage, and other information, such as order of births, both in censuses and in the registration of vital events. It is apparent that a large proportion of persons and a large proportion of deaths are recorded in wrong five-year age intervals, that first and second births are recorded at higher than the correct order, and that the duration of a mother's marriage at the birth of a child is often overstated for many births (in some years fewer than a hundred births in all Egypt are reported as having occurred to women married less than a year). It is also clear that parity (number of live births ever experienced) is understated, at least by older women.

The existence of unusually extensive, although imprecise, information has dictated the strategy employed in constructing our principal estimates. The general approach has been to use interrelations among data taken from censuses and from registers to estimate the extent of errors in each, and to base estimates of fertility and mortality on data that have been adjusted for the biases that are detected.

4 Methods of Estimation

The discussion of methods of estimation in the next few pages of this report is limited to a description and brief justification of the broad strategy followed. More detailed explanations are presented in a series of appendixes. As intimated in the preceding section on Egyptian data, the strategy of estimation entailed using information from censuses to estimate the extent of errors in the registration of events. Numbers of registered births, infant deaths, and deaths beyond infancy were then adjusted for the errors thus estimated. Underregistration of births and infant deaths was determined at particular dates (dates just before the censuses containing the relevant information). At these dates the estimated extent of underregistration was determined separately for different segments of Egypt, such as the metropolitan populations of Cairo and Alexandria, populations residing in areas having Health Bureaus, and populations residing in areas without Health Bureaus.

INFANT MORTALITY

Perhaps the best known and most robust technique of indirect estimation of vital rates from census data is the estimation of mortality in early childhood from reports in a census or survey of the proportion dead among the total number of children ever born to young mothers. The original procedure was invented by William Brass; alternative versions have been developed by Sullivan and Trussell. Specifically, the proportion who have died of all children borne by women 20-24 can be converted into a useful estimate of what fraction of the newly born die before the second anniversary of their birth, and which can then be converted into a slightly less accurate estimate of the fraction who die before the first anniversary, the infant mortality rate.

The appropriate questions (on number of children ever born, and number still surviving) were asked in the censuses of 1947 and 1976; and the answers were tabulated both by age and duration of marriage of the mother. The information on child survival derived from these two censuses was the basis for estimates of how nearly correct the infant mortality rates recorded for each governorate in 1946-47 and 1975-76 were.

For 1946-47, the quality of two rates of infant mortality in each governorate was estimated: the infant mortality rate in the Health Bureau areas in each governorate, and the infant mortality rate in the entire governorate. In all instances, the infant mortality rate (IMR) recorded in the Health Bureau areas was greater than the rate recorded for the whole governorate (reflecting better registration in the Health Bureaus, not genuinely higher mortality). To obtain corrected infant mortality rates for 1927 to 1961 (the era of the Health Bureaus), it was assumed that the adjustment factor necessary to convert the IMR registered in the Health Bureaus in a governorate into the IMR calculated for the entire governorate for 1946-47 from 1947 census data on child survival was the appropriate adjustment factor to convert the Health Bureau IMR in other years to the proper IMR for the governorate in question. This assumption makes allowance for the increasing proportion of the population in Health Bureau areas, an increase that resulted from creation of additional Health Bureaus, expansion of boundaries, and migration. Between 1947 and 1960, the proportion of the population in Health Bureau areas rose from 38 to 47 percent, and increased in every governorate except the wholly urban governorates, which had no non-Health Bureau segments.

For 1975-76, the quality of recorded infant mortality rates in the rural and urban sectors of each governorate was estimated separately on the basis of rural and urban data on child survival in the 1976 census. In all but two governorates urban infant mortality was better recorded than rural. (In the two exceptional instances, both urban and rural registrations were estimated to be at least 97 percent complete.) Registration was found to be more nearly complete in Lower than in Upper Egypt.

A new uniform system of administering vital statistics was instituted in 1962, and separate tabulations of vital statistics for Health Bureau areas were discontinued. Through 1961, the estimated IMR for Egypt is the weighted sum of the estimates for the governorates, and the estimate for each governorate is the rate for the Health Bureau areas within the governorate corrected by the factor established for 1946-47. From 1962 to 1976, the estimated IMR for Egypt is the weighted sum of the IMR for Cairo and Alexandria, rural Lower Egypt, urban Lower Egypt, rural Upper Egypt, and urban Upper Egypt--each adjusted for the completeness of registration determined for each sector in 1975-76. Thus the basis for adjusting IMR changes from 1961 to 1962. The discontinuity in adjustment serves to reduce (and almost eliminate) a sudden increase in the unadjusted registered rate from 1961 to 1962. (The registered rate rises by 22 percent, the adjusted rate by only 3 percent.) Evidently, registration of infant mortality was more nearly complete in 1962 under the new registration procedures than in 1961 under the old. (See Appendix A for a more complete discussion.)

FERTILITY

Completeness of birth registration in each governorate was estimated for the years prior to the 1947 and 1976 censuses by the classic procedure of the reverse projection of the enumerated child population, in this instance at ages between exact age 1 and exact age 5. The two obstacles to estimation of the true number of births by reverse projection of the number of children counted in a census are (1) the difficulty of determining the correct survival factor when deaths are not correctly registered; and (2) the inaccuracy with which numbers of children are recorded in censuses because of omission and misreporting of age.

The first problem was addressed by basing the reverse survival factors ($4 \cdot \ell_0 / {}_4L_1$ in life table terminology) on recorded infant mortality for the appropriate years, after adjustment for the estimated degree of underregistration. (The relation of ${}_4L_1$ to corrected average infant mortality was taken from the "West" family of Coale-Demeny model life tables.)

The second problem is more intractable, since misstatement of age and possible differential omission of young children are undeniable features of Egyptian censuses. For example, the number of persons recorded as 10-14 in 1947 is 5 percent greater than the number recorded as less than 5 in 1937, despite the very high mortality to which children were then subject. This more difficult problem was addressed by introducing two tactics designed to minimize the effect of the under-enumeration of young children. The first tactic was to select an age interval in which the undercount is less severe than in more conventional intervals (under 1 or under 5) and the second was to adjust the recorded number at ages 1 to 5 in every governorate by a factor that would equate reverse-projected births with registered births in Cairo and Alexandria. The number of children under 1 year of age is very frequently understated in censuses, because of two factors that cannot generally be disentangled-- overstatement of age of infants (including especially those in the last few months of their first year) and omission of infants. The number of children under 5 years of age is also very frequently understated because of analogous factors--overstatement of age of those approaching 5, and omission, perhaps most frequently of young infants. The number of children counted as 1 to 5 thus gains from overstatement of the age of infants, and loses from overstatement of age of 3- and 4-year-olds, and is not affected by omission of infants under 1. A priori, then, the number of children in the segment from 1 to 5 should be less severely undercounted than either the number under 1 or the number under 5.

It is unlikely, merely because the recorded number is affected by offsetting biases, that the count of children aged 1 to 5 in each Egyptian census is a suitable foundation for determining with any exactness the number of births one to five years before the census. The correctness of the count of children aged 1 to 5 in each census was judged by the match in Cairo and Alexandria between the reverse projection and the number of births registered in the appropriate pre-censal years, on the assumption that registration of births was approximately complete in the two large cities. A correction was applied (if needed) to the enumerated population aged 1 to 5 in Cairo and Alexandria such that this population projected back to birth would agree with the number of births registered in those cities one to five years before the census. The same proportionate correction was then applied to the enumerated population aged 1 to 5 in the same census in all other governorates. In other words, the population aged 1 to 5 in each governorate was adjusted by the factor appropriate to the metropolitan populations, on the assumption that births in the latter were fully registered.

There are many reasons for believing that registration is relatively complete in the two major cities. Both have been fully within Health Bureau administration as far back as our estimates go. The sex ratio at birth, consistently too masculine (compared to general experience) in Egyptian registered births, is highest (most exaggerated) in areas not covered by Health Bureaus, second in Health Bureaus in other than the urban governorates, and is lowest (within the normal range) in Cairo and Alexandria. Finally, the level of the infant mortality rate in the large cities, relative to infant mortality derived from child survival (in the 1940s and the 1970s) is a strong indication of good registration. Complete registration of infant mortality is more difficult to achieve than complete birth registration; if infant deaths are well recorded, births are very likely well recorded also.

The reverse projection to birth of the population aged 1 to 5 in 1976 matched the number of registered births in 1972 to 1975 in Cairo and Alexandria within less than one half of one percent; hence no adjustment was made to the enumerated child population in any of the governorates. The corresponding reverse projection for the two cities in 1947 was 94.3 percent of registered births; hence the enumerated population at ages 1 to 5 in every governorate was increased by 1/.943 before reverse projection was carried out. Completeness of registration of births and infant mortality in the 1940s and 1970s for the two large cities, for Upper Egypt, and Lower Egypt are listed in Table 7. At the later period separate figures are given for the rural and urban sectors of Upper and Lower Egypt. Note the generally much greater completeness of registration of births than of infant deaths, the progression of completeness from most complete in the metropolises to least complete in Upper Egypt, and the greater completeness in urban areas than in rural areas in the 1970s.

The estimated completeness of registration of births in each governorate in 1942-45 and 1972-75 was the basis for approximate estimates of completeness by governorate in 1960, and for completeness in all Egypt for 1927 to 1947 and for 1960 to 1976. (Because of extensive and

TABLE 7 Estimated Completeness of Registration of Births and Infant Mortality, 1940s and 1970s: Egypt

Region	Births	Infant Mortality
Part A. 1940s	(mid 1942 - mid 1946)	(1946-47)
Egypt	.890	.837
Cairo and Alexandria	1.001	1.106[a]
Lower Egypt	.929	.791[a]
Upper Egypt	.804	.708[a]
Part B. 1970s	(1972-75)	(1975-76)
Egypt	.964	.753
Cairo and Alexandria	1.004	.984
Lower Egypt	.997	.807
Rural	.997	.780
Urban	.996	.896
Upper Egypt	.911	.625
Rural	.888	.537
Urban	.975	.879

[a] Completeness of infant mortality in health bureau areas.

diverse evidence of especially poor registration during the 1950s, quantitative estimates of the extent of underregistration from year to year were not attempted for 1948 to 1959.)

El-Badry (1965) has also estimated the birth rate for all Egypt for the period one to five years before the 1947 census. Our estimate of the birth rate, adjusted for the calculated degree of underenumeration, agrees within a small fraction of 1 percent with El-Badry's estimate. Therefore, El-Badry's estimates of the Egyptian birth rate for 1927 to 1947 have been adopted. To make his estimates, El-Badry accepted the registered births in the urban governorates (100 percent Health Bureau) and in the urban Health Bureau areas in other governorates as correct. He also assumed that the birth rate in the entire rural population of the governorate was the same as that in the rural Health Bureau areas of that governorate. The agreement of El-Badry's estimate of Egypt's birth rate with that obtained by reverse projection of the population aged 1 to 5 (adjusted for underenumeration) implies that registration of births in the Health Bureaus was essentially complete.

Completeness of birth registration in 1956-59 was calculated for each governorate by reverse projection of the population aged 1 to 5 in the 1960 census, with the intention of finding an adjustment that could be applied to registered births for 1960 and 1961, to facilitate construction of fertility measures and indexes by governorate and region as of the 1960 census. Because of extensive evidence of particularly poor registration in the 1950s (including 1956 and 1957), it is apparent that the average underregistration for 1956 to 1959 was much greater, especially in some governorates, than in 1960 or 1961. It was therefore decided--for want of a better solution--to estimate the completeness of birth registration in each governorate in 1960-61 as the arithmetic mean of the completeness estimated for 1942-46 and 1972-75. For 1962 to 1972, completeness of birth registration for Egypt as a whole was assumed to change linearly from the estimated 0.927 for 1960-61 to 0.964 for 1972-75. (See Appendix B for additional discussion.)

ADULT MORTALITY

To depict changes in mortality since 1927, we have constructed separate annual approximations of mortality up to age 5 and above age 5, for males and females. Mortality under age 5 in each calendar year was represented by a segment of a "West" model life table for each sex--the segment from birth to age 5. The appropriate model life table was determined by finding the mortality level in the "West" family at which infant mortality for the two sexes combined matched the adjusted infant mortality rate that had been calculated for the year in question.

Estimation of mortality over age 5 was accomplished, as were our other estimates, by combining information on registered events (in this instance the number of deaths to persons over 10 classified by age and sex) with information drawn from censuses (in this instance the number of persons at census dates, classified by age and sex, and interpolated in other years to approximate the numbers that might have been counted had censuses been taken annually). The method is an adaptation of a new procedure developed by Preston and refined by others (Preston et al., 1980). The procedure is based on the equality in a stable population (and near equality in a population in which mortality has recently declined) of the number of persons at each age and the sum of the deaths at all higher ages, after multiplication of the deaths at each higher age by a suitable exponential factor based on the population's estimated rate of increase. Because of this equality, it is possible to calculate the number of persons above age 10, age 15, age 20, etc., that are implied by the recorded number of deaths (and the rate of increase). If deaths are fully registered, the calculated number above each age very nearly matches the number recorded in a census, or interpolated for a non-census year; if deaths are not fully registered, the ratio of the calculated number to the recorded number is an estimate of the completeness of death registration.

In Egypt the application of this procedure was complicated by the obvious severe overstatement of the number of deaths at very advanced ages. It is clear that the excess numbers of reported deaths at ages above 70 and 80 are at the expense of understated numbers at earlier ages from 10 to 70. Our inference, which we are confident is correct, is that deaths of persons whose age is unknown are reported at the ages above 70 (mostly above 80, in fact).

Because of this feature of the registration of deaths in Egypt, the estimation of the mortality schedule above age 5 required several steps. First, the true proportion of deaths above age 70 was approximated by finding the proportion of deaths over 70 in a model stable population matching the population of the year in question in growth rate (of the population over 10) and in broad structure (namely, the ratio of persons aged 10 to 50 to persons 10 and over). Deaths over 70 in excess of the proportion thus estimated were redistributed, being added pro rata to deaths at ages 10 to 70. Second, completeness of death registration among deaths over age 10 was calculated by comparing the expected population, derived from the number of deaths (so redistributed) and the rate of increase, and the population derived from census counts. It was concluded that from 1936 to 1946, male deaths above age 10 were underregistered by about 5 percent, and female deaths by about 20 percent. From 1947 until 1960, death registration deteriorated, with completeness in the mid-1950s falling below 60 percent for males, and below 50 percent for females but recovering after 1960 to about 100 percent for males, and 85 percent for females. Third, the death rate over age 10 for each sex was recalculated, allowing for the estimated extent of underregistration. Finally, a "South" model life table producing the estimated death rate over age 10 in a stable population with the estimated rate of increase was selected. The mortality schedule above age 5, and the expectation of life at age 5 (for each sex) in this model life table were accepted as approximately appropriate. Another possibility would have been to adjust the recorded number of deaths (after reallocation of deaths from ages over 70 to ages 10 to 70) for the estimated degree of omission, and calculate an age-specific mortality schedule. Expectation of life at age 5 derived in this alternative way is very little different, but certain features resulting from age misreporting are probably farther from the true schedule than is the model life table. (See Appendix C for a more detailed discussion.)

PROJECTING THE POPULATION

A population projection was employed to reconstitute the Egyptian population incorporating an initial population that reallocated the population enumerated in 1927 to a stable age distribution. The stable population combined the male and female life tables we constructed for the period with an estimated birth rate based on registered births adjusted by the average factor employed in the 1930s. In each subsequent five-year period, a life table was employed that incorporated average child mortality from estimated IMRs, and average mortality over age 5 from corrected death rates over age 10 and the rate of increase. In each quinquennium, the number of births introduced to determine the population less than 5 was the adjusted number described in the "Fertility" section above. The projection is discussed in detail in Appendix D.

The projection produces constructed populations at the later census dates agreeing closely with the total number enumerated in 1947 and 1960. Differences between the projected and enumerated totals arise for 1937, when the census appears to have undercounted the population by some 4 percent more than other censuses, and for 1976, when much of the difference between count and projection is explained by a large number of Egyptians abroad. The projected populations also agree in age structure with the enumerated populations (except for consistent age- and sex-specific biases in the censuses). This agreement does not prove that the estimates of fertility and mortality are correct (there could be offsetting biases in estimating fertility and child mortality that would yield a projection consistent with the censuses), but it does strongly support the estimated trends.

Appendix A
Estimation of Infant Mortality

Chapter 4, devoted to methods of estimation, describes the use of data from the 1947 and 1976 censuses on child survival to estimate the degree of underregistration of infant mortality. This appendix provides more details on the measurement of underregistration of infant mortality and the construction of corrected infant mortality rates.

THE BRASS ESTIMATION PROCEDURE

It is fortunate that the censuses of 1947 and 1976 included questions asked of every ever-married woman concerning the number of children she had borne in her lifetime and the number of these children still living. In 1947 the only conclusion about mortality that could be inferred from such data was the obvious qualitative inference that a lower proportion surviving among the children ever born to women at any particular age or duration of marriage implied higher mortality rates in infancy and childhood in the population. By the 1960s, Brass had invented a procedure to go beyond mere qualitative observation and to determine from these data sound numerical estimates of the fraction of children who die and the fraction who survive between birth and specified precise early anniversaries of birth. If p(x) is the proportion that survives to age x, and q(x) the proportion that dies before age x, it is possible to estimate q(2), q(3), and q(5)--and their complements p(2), etc.--by the methods that Brass devised, methods subsequently refined by Sullivan and Trussell (Brass and Coale, 1968; Sullivan, 1972; and Trussell, 1975).

We have made use of the generally most trustworthy of the Brass-style estimates, that of the proportion dying before exact age 2, [q(2)]; q(2) is derived from the proportion dead among children ever born to women in the age interval 20-24 or in the duration of marriage interval less than five years. The rationale of the Brass estimation procedure is as follows:

(1) The proportion dead among children born to women in a particular interval of marriage duration or age depends on two factors: the mortality schedule to which the children have been subject and the distribution of births through time in the interval prior to the census survey. The higher the age-specific death rates the higher the proportion dead; the greater the concentration of births in the recent past (i.e., the younger the children would be in the absence of mortality), the lower is the proportion dead.

(2) The approximate distribution by year of birth of the births the women have had in the years preceding the census can be inferred from the sequence of average parities (average number of children ever born) for women in the age intervals 15-19, 20-24, and 25-29 or in the marriage-duration intervals less than 5, 5-9, and 10-14 years. Armed with approximate knowledge of the time distribution of births, one can estimate the level of mortality rates to which the children have been subject, a level expressible as the proportion dying before the second birthday when information on child survival is taken from women in the age interval 20-24 or in the duration interval 0-4.

For our estimates, we used Trussell's version of the calculation procedures; the result of using the Brass or Sullivan versions is to modify the estimates only very slightly. The estimation of mortality in the early segment of life by what is generally known as the Brass procedures has proven reliable in applications to data from different populations in both more developed and less developed parts of the world (United Nations, Department of Economic and Social Affairs [Manual IV], 1967:36). However, even with perfectly accurate data there is some uncertainty about such estimates because information about the age pattern of mortality to which the younger population is subject may be lacking, because infant mortality among children born to young mothers differs from infant mortality among children born to older mothers, because changes in infant mortality raise difficult questions about the period to which the estimates pertain, and because recent changes in fertility may make the estimation of the past time pattern of births from the sequence of average parities in the census imprecise. Additional problems arise from the possible omission of some dead children in responding to these questions, and from misreporting of age and duration of marriage in the censuses of many developing countries, including Egypt.

In Egypt the estimates of q(2) derived from data on child survival classified by age and classified by duration of marriage do not agree, as ideally they should. In each of the three panels of Figure A-1 the values of q(2) derived from the proportion dead among children ever born reported by women aged 20-24 (age-based estimates) are compared with the values of q(2) derived from the proportion dead reported by women of marriage duration less than five years (duration-based estimates). In the first panel, the two sets of estimates are compared for the governorates of Egypt in 1947; in the second panel, for the urban population of the governorates in 1976; and in the third panel, for the rural population of the governorates in 1976. In all three instances there is a very strong correlation between the two sets of estimates, an agreement that is scarcely surprising since the underlying data are essentially two different tabulations of responses recorded from virtually the same women (most women in the first five years of marriage are 20-24 years of age). In the rural population in 1976, the two sets of estimates are in almost perfect agreement, but in the urban population in 1976, and the combined urban and rural populations in 1947, the age-based estimates are higher, with only one exception.

Derived from these estimated q(2)s were estimates of q(1); the estimated q(1)s in turn were compared with registered infant mortality rates in a period before the censuses to determine the extent of underregistration. One question we faced was whether the duration-based q(2)s or the age-based q(2)s should be chosen as the source of the estimated extent of underregistration of infant mortality. Conversion of q(2) to q(1) was accomplished by assuming that the relation between q(1) and q(2) in Egypt is the relation found in the "West" model life tables (namely, that q(1) equals 0.80q(2)).

Estimates for 1946-47

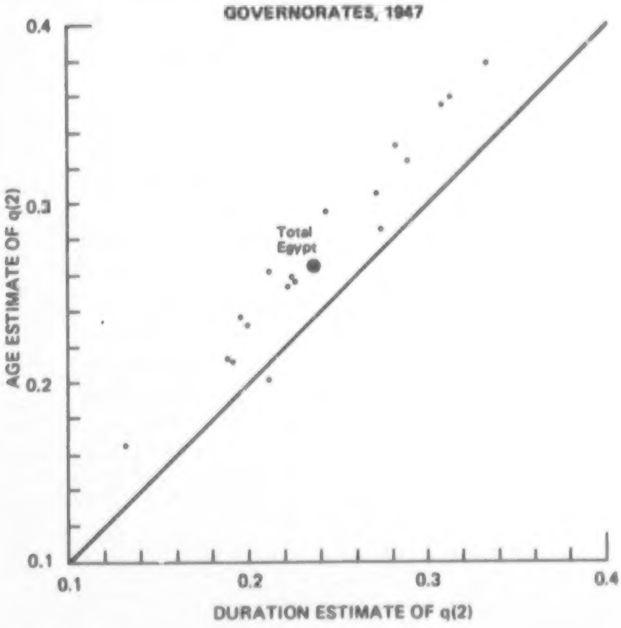
In Figure A-2 the average IMR in 1946-47 in the Health Bureau areas in each governorate is compared with the rate in the remainder of the governorate. The large differences indicate the existence of extensive underregistration in the areas not within Health Bureau administration.

Comparisons of child-survival-based estimates of infant mortality with registered infant mortality in the period prior to the 1947 census are complicated by large reductions in registered infant mortality from 1943 to 1947. The registered IMR for urban areas in Egypt declined from 225 to 171 during this period.

In the three panels of Figure A-3, there are three comparisons of q(1) derived from child survival as reported in the 1947 census with infant mortality rates as reported in the Health Bureau areas. The first panel compares age-based estimates of q(1) with the recorded IMR in 1945-46. The other two panels compare the recorded IMR in 1946-47 with duration-based and age-based estimates of q(1), respectively.

Note the following features of these comparisons:

(1) Age-based estimates of q(1), which are higher than duration-based estimates, are surpassed by the average IMR for 1945-46 recorded in the five urban governorates



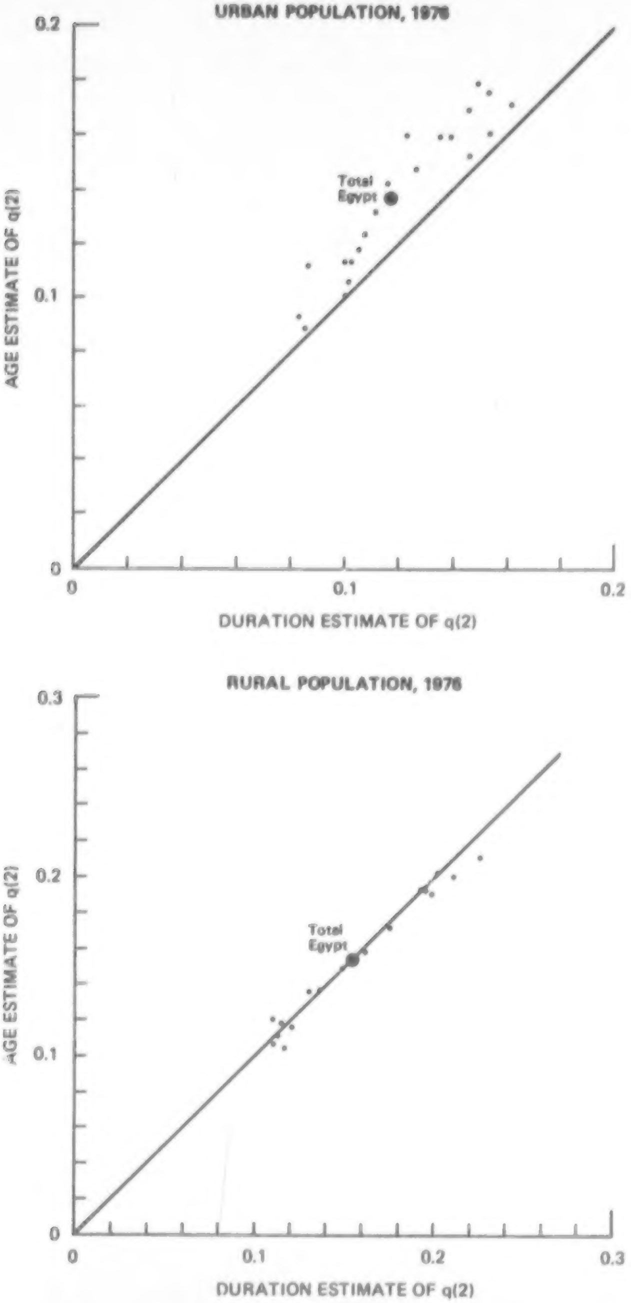


FIGURE A.1 Comparison of Child Mortality Estimates, q(2), Based on the Proportion Dead Among Children Ever Born to Women Married Less than Five Years (Duration Basis) and to Women Aged 20 to 24 (Age Basis), 1947 and 1976: Egypt

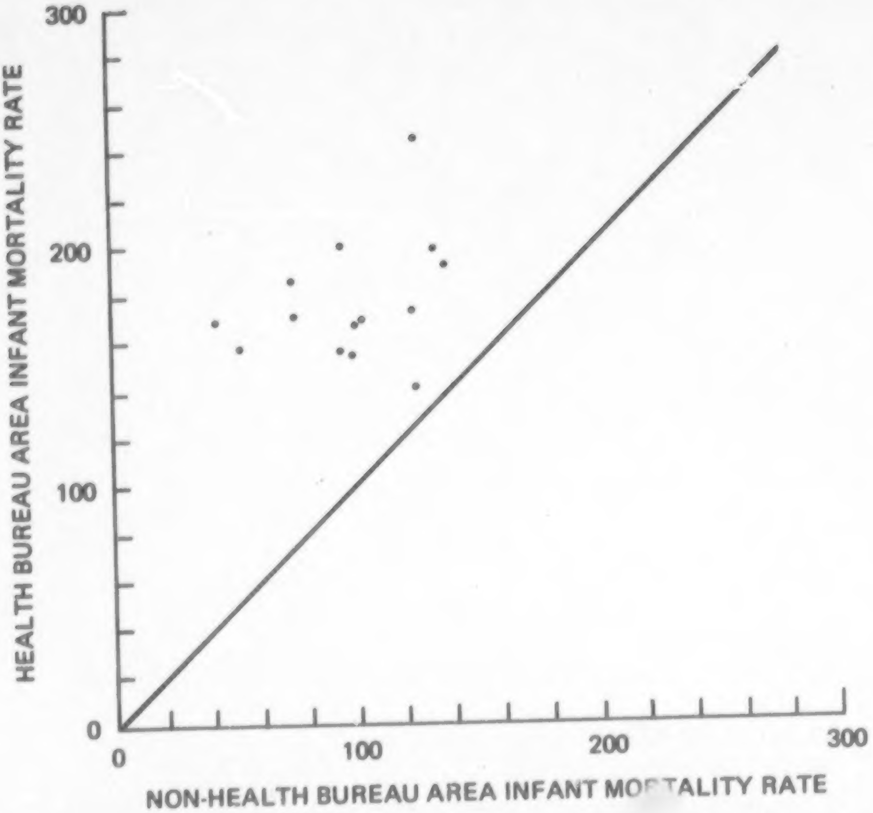


FIGURE A.2 Comparison of the Average Infant Mortality in Health Bureau Areas and Non-Health Bureau Areas of the Governorates, 1946-47: Egypt

of Cairo, Alexandria, Damietta, Canal, and Suez--in all but Canal by a large margin. (Reporting of infant mortality in these governorates is expected to be better than elsewhere but not more complete than reporting of births. Delayed registration, transferring into 1945 infant deaths not reported in earlier years, might offer one explanation for the higher recorded IMR.) Apparently q(1) estimated from child survival is too low when compared with the IMR for 1945-46. Yet, since the proportion dead among children ever born reflects the mortality over a several-year period centered one to two years before the census, comparing the average IMR for 1945-46 with estimates of q(1) from the 1947 census (taken in March) is appropriate.

(2) The duration-based estimates of q(1) are exceeded by the reported IMR even at the lower rates in 1946-47 in all five urban governorates, and in Behera and Aswan as well. When age-based estimates are compared with 1946-47 infant mortality rates, on the other hand, they are about equal to the recorded rates in Damietta, Alexandria, and Suez; are lower than the recorded rates in Cairo; and are slightly higher than the recorded rates in Canal.

(3) The imputation of more than 100 percent reporting of infant mortality rates in urban governorates, or of underestimation of infant mortality in these same areas from reported child survival is avoided only when the higher (age-based) estimates are compared with the lower (1946-47) infant mortality rates. The inclusion of 1947 infant mortality in the comparison even though the census was taken in March of that year is justified if we assume that there was some delay in the recording of deaths in the 1940s, so that many events labeled "1947" occurred in 1946. Egyptian vital statistics consistently pertain to year of registration, not year of occurrence.

Completeness of recording of infant mortality rates in the Health Bureau areas is judged, then, by the comparison of recorded rates in 1946-47 with age-based estimates of q(1) from the 1947 census. An alternative procedure, yielding not very different estimates of completeness, is to assume that the age-based q(1)s are too low (since they fall short of recorded data for 1945-46 in the urban governorates), and to adjust all age-based q(1)s upward by enough to match the IMR for 1945-46 in the urban governorates.

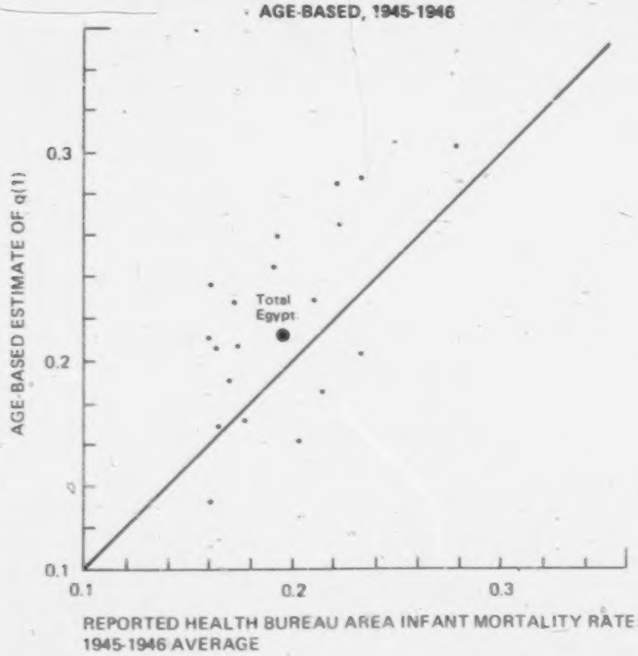
Estimates for 1975-76

In 1976, as noted earlier, there is very little difference between the age-based and duration-based q(2)s in the rural areas. In Figure A-4, age-based and duration-based q(1)s are compared with the registered IMR for 1975-76 for the urban areas of the governorates. The age-based estimates are virtually equaled by the registered rates in five of the urban areas; in the remaining governorates the registered rates fall short of the age-based estimates of q(1). On the other hand, the duration-based estimates are less than the registered IMRs in a majority of the urban areas, and in the urban population of Egypt as a whole. Again, we find the age-based estimates a better choice for calculating the extent of underregistration of infant mortality.

ESTIMATES OF COMPLETENESS OF INFANT DEATH REGISTRATION

Estimates of completeness of infant mortality rates by governorate in 1946-47 and 1975-76 are shown in Table A-1. For the earlier date estimated completeness in the Health Bureau areas, the non-Health Bureau areas, and the total area of each governorate is tabulated; for the later date estimated completeness in the rural areas, the urban areas, and the total area of each governorate is listed. For 1946-47 it is implicitly assumed that q(1) inferred from child survival in the census is the appropriate estimate of infant mortality for both the Health Bureau and non-Health Bureau sectors of each governorate.

These estimates show the universally more complete recording of IMR in the Health Bureau areas in 1946-47, and the almost universally more complete recording of IMR in the urban areas in 1975-76. For 1946-47 the estimated completeness of registration of infant mortality is less than 55 percent in all Upper Egypt governorates except Giza, between 55 and 65 percent in all Lower Egypt governorates, and fully complete in the urban governorates. For 1975-76, registration remains less than 65 percent complete in all Upper Egypt governorates except Giza and Aswan and is above 70 percent in all Lower Egypt governorates except Kafr-el-Sheik. In spite



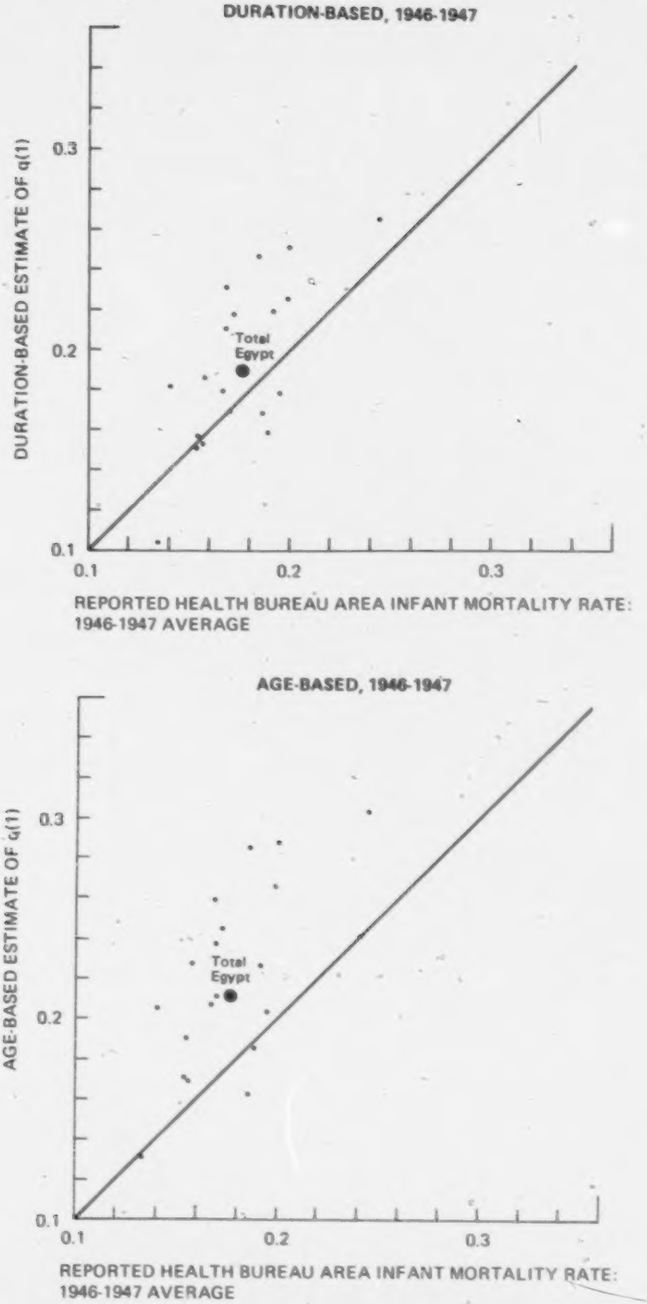


FIGURE A.3 Comparison of the Reported Infant Mortality Rates in Health Bureau Areas and Age- and Duration-Based Estimates of q(1) for the Governorates, 1945-47: Egypt

TABLE A-1 Estimated Completeness of Infant Mortality Rates by Governorate, 1946-47 and 1975-76: Egypt

Governorate	1946-47 Health Bureau Areas	1946-47 Non-Health Bureau Areas	1946-47 Total Governorate	1975-76 Urban Areas	1975-76 Rural Areas	1975-76 Total Governorate
Cairo	1.151	-- [a]	1.151	1.009	-- [b]	1.009
Alexandria	1.019	-- [a]	1.019	0.925	-- [b]	0.925
Canal	0.903	0.601	0.875	0.839[c]	-- [b]	0.839
Suez	0.960	0.861	0.953	0.795	-- [b]	0.795
Damietta	1.014	-- [a]	1.014	0.849	0.744	0.756
Dakahlia	0.684	0.607	0.627	0.993	0.674	0.725
Sharkia	0.810	0.486	0.567	0.835	0.712	0.730
Kalyubia	0.708	0.510	0.572	0.905	0.849	0.868
Kafr-el-Sheik[d]	--	--	--	0.855	0.515	0.576
Gharbia	0.818	0.519	0.600	0.978	0.995	0.989
Menoufia	0.841	0.603	0.654	1.011	1.033	1.036
Behera	0.925	0.498	0.615	0.872	0.684	0.724
Ismailia[b]	--	--	--	0.863	0.847	0.848
Giza	0.751	0.503	0.587	0.905	0.767	0.833
Beni-Suef	0.652	0.261	0.363	0.942	0.463	0.561
Fayoum	0.809	0.413	0.504	0.763	0.550	0.596
Minya	0.697	0.330	0.427	0.840	0.529	0.580
Assyiut	0.655	0.397	0.478	0.867	0.558	0.623
Souhag	0.694	0.225	0.364	0.873	0.497	0.577
Kena	0.714	0.179	0.354	0.862	0.358	0.460
Aswan	0.813	0.358	0.526	1.013	0.774	0.850

[a] No non-health bureau areas.
[b] No rural areas.
[c] Includes only Port Said in 1975-76.
[d] Not separate governorate in 1946-47.

of the passage of time and changed system of registration, geographic differences persist, and registration of infant deaths in Upper Egypt still covers only a little more than half the real infant mortality rate.

NATIONAL ESTIMATES OF ANNUAL INFANT MORTALITY

To estimate the national infant mortality rate for individual years from 1927 to 1961 (shown in Table 2), the IMR in the Health Bureau areas within each governorate was multiplied by the factor that converts the 1946-47 average Health Bureau IMR into the age-based estimate of IMR derived from child survival data in the 1947 census. This procedure makes appropriate allowance for the increasing fraction of the governorate population within Health Bureau areas. The increasing coverage of Health Bureaus tends to improve the overall completeness of recording of infant mortality, and any assumption of a constant degree of completeness for the governorate as a whole would not allow for the normal increase in completeness as Health Bureau areas came to include a larger fraction of the governorate's population.

We assumed that from 1962 to 1976, under the reorganized system of vital registration, the completeness of recording of IMR in each major subdivision (Cairo and Alexandria, urban Lower Egypt, rural Lower Egypt, urban Upper Egypt, and rural Upper Egypt) was constant at the level estimated for 1975-76. In Figure A-5, the estimated completeness of registration

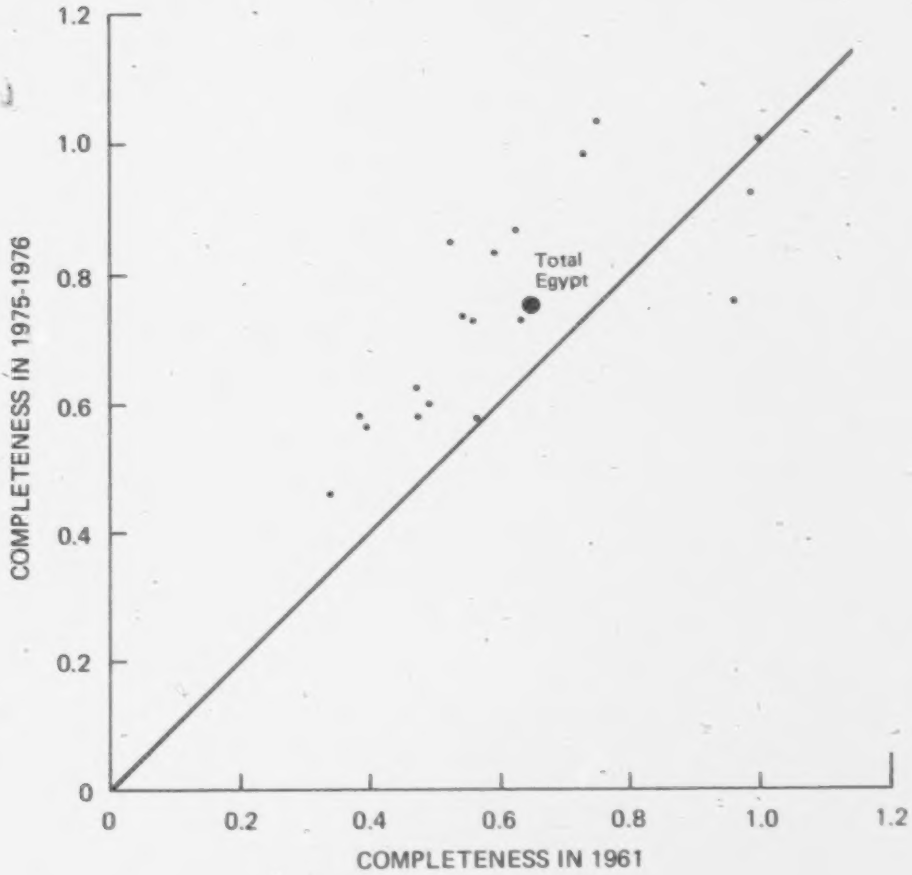


FIGURE A.5 Comparison of the Completeness of Registered Infant Mortality in 1961 and 1975-76 by Governorate: Egypt

in each governorate in 1961 (the IMR for the whole governorate based on registration relative to the Health Bureau IMR adjusted by the factor determined for 1946-47) is compared with the estimated completeness in 1975-76. Except for Cairo and Alexandria (virtually complete by both estimates), Damietta (an urban governorate in 1947 when 1961 completeness is determined, but with additional rural districts added later), Fayoum, and Aswan, the estimates of completeness in 1961 and 1975-76 fall close to a line in which completeness in 1961 is about 70 percent that of 1975-76. The consistent difference in completeness in most of the governorates (and the understandable exceptions of Cairo, Alexandria, and Damietta) is reassuring, since one set of estimates is derived from data taken from the 1947 census and from Health Bureaus in 1946-47, and the other set is derived from data taken from the 1976 census and from registration in whole governorates in 1975-76.

The question remains, however, whether the improvement in estimated completeness is justified, and whether the higher degree of completeness can be assumed to start in 1962 with the initiation of the new system of registration. Unfortunately, the 1960 census did not include tabulations of children ever born and children surviving to permit an independent verification of completeness just prior to the 1960 census; nor is there any verification of the rates in 1962. However, the sequence of registered infant mortality rates provides a clue that supports the validity of the conclusion that completeness increased in 1962 with the introduction of the new system of registration. In Figure A-6 the IMR derived from registration and the IMR adjusted by our estimates are shown for 1937 to 1976. According to the registered figures, IMR rose from 108 in 1961 to 134 in 1962 (24 percent); according to the adjusted figures, the increase was from 166 to 171 (3 percent). The registered figures show that the infant mortality rate did not fall as low as in 1961 until 1971, while the adjusted figures show that the rate was lower than in 1961 only two years later. The registered rates indicate a plateau of infant mortality during the 1960s, before the decline resumes in 1969. Without adjustments for completeness, the plateau is at a tangibly higher level than the IMR in the years 1958-61; when adjusted to reflect increased completeness beginning in 1962, the plateau is somewhat below the average for 1958-61. In other words, the acceptance of uniformly higher completeness beginning in 1962 does not

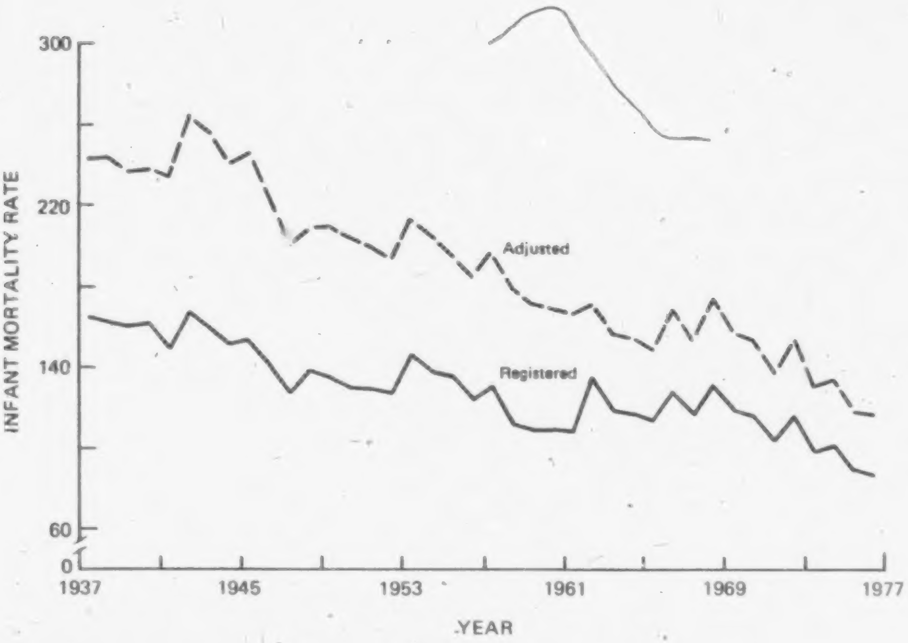


FIGURE A.6 Infant Mortality Rate Derived from Registration and After Adjustment for Age-Based Estimates of Completeness, 1937-76: Egypt

introduce a discontinuity in the estimated sequence of IMRs but rather repairs a discontinuity in the unadjusted sequence.

LIMITATIONS OF THE ESTIMATES

The adjusted set of infant mortality rates are certainly a better representation of the evolution of IMR in Egypt than the official, unadjusted figures. Adjustment by using child survival data from the censuses is an appropriate source of correction, although it is weakened, it must be conceded, by the differences between child mortality estimates derived from age-based and duration-based data and by the appearance of overreporting in the urban governorates for 1945-46.

The inconsistency of the two sets of estimates is almost certainly caused in large part by inaccurate reporting of age and of duration of marriage. When estimates of the number of married women by duration of marriage in 1947 are made from registered marriages by year of occurrence, number of divorces by year of occurrence and duration of marriage, and an allowance for attrition by mortality, the number of women married less than five years is 54 percent greater than the number married five to nine years. In the census, however, the number of those married less than five years is only 25 percent greater than the number in the next duration interval. The number at duration less than five is obviously understated in the census, probably because of overstatement of duration at durations near to five years. There is also a very large number of women at duration less than five who have no children, and another large number tabulated as having given no response to the questions about children ever born and children surviving. The many "no responses" recorded are the result of interviewers' having frequently left a blank instead of inserting a zero at this point in the questionnaire for women with no children. It was necessary to apply El-Badry's correction for converting "no response" to zero children, increasing the estimated number with no children to 53 percent of the women at duration less than five (El-Badry, 1961). The high proportion of childless women at duration less than five arises from overstatement of duration, so that many women married three and a half or four years are reported in duration interval 5-9, and from the custom in Egypt of formalizing marriage by a ceremony called "signing the book" typically several months before the bride and groom take up residence together. Thus the initiation of cohabitation is later than reported marriage, increasing the number of childless women reported as married less than five years.

Age misreporting is also severe for young women, and probably associated with marital status and perhaps parity. That is to say that a woman (not being able, typically, to report her own age) is estimated as over age 20 if she is married and has borne one or more children, and under age 20 if still unmarried. In short, the sequence of reported parities--by age or by duration of marriage--is unlikely to be accurately associated with true age or true parity, and thus the conversion factors for deriving q(2) from proportion dead among children ever born are not fully trustworthy. Moreover, there may be a tendency to omit dead children in reporting numbers of children ever born, a tendency that would contribute to a slight underestimate of q(2)--and in turn q(1)--from child survival statistics.

ANOTHER ESTIMATE OF THE COMPLETENESS OF INFANT DEATH REGISTRATION IN THE 1970S

Independent estimates of the completeness of recording of infant deaths in 1974-75 were derived from a survey conducted by the Central Agency for Public Mobilisation and Statistics (CAPMAS).. Vital events were observed in a large nationwide sample of households and then checked against the registration records (see Appendix F).

The degree of non-registration of infant deaths determined in this survey was quite a bit larger than our estimates based on child-survival, as shown in Table A-2. The pattern was the same; both methods of estimation indicate a high rate of omission in the rural areas, with over 50 percent omission in rural Upper Egypt, and 22 to 30 percent in rural Lower Egypt. For the urban populations, the survey estimates of omission are up to twice as high as the child survival estimates. The child survival estimates may be too low, but if matching is imperfect, the survey estimates may be too high. We have retained the child-survival-based estimates from the 1976 census because they are more compatible with the estimates for earlier years derived from child survival data in 1947.

TABLE A-2 Estimated Understatement of Infant Mortality, 1970s: Egypt

Region	Underregistration of infant deaths, 1974-75, CAPMAS Survey	Understatement of infant mortality rate, 1975-76, Child Survival Method	Implied omission of infant deaths 1975-76, allowing for underregistration of births estimated by reverse projection
Cairo and Alexandria	.038	.016	.016
Urban Lower Egypt	.152	.104	.104
Urban Upper Egypt	.251	.121	.124
Rural Lower Egypt	.297	.220	.221
Rural Upper Egypt	.555	.463	.522

Appendix B
Estimation of Fertility

COMPLETENESS OF BIRTH REGISTRATION

As described in Chapter 4, reverse projection of the number of children aged 1 to 5 was used to provide a standard of comparison for the number of registered births. The details of the procedure are summarized below. The population aged 1 to 5 is designated as ${}_4P_1$ to connote the population in the interval four years in width (pre-subscript) beginning at exact age 1 (post-subscript), as in the symbols employed in life tables.

(1) The expected number of births in a governorate in the period one to five years before the census is calculated as ${}_4P_1^* \cdot (4 \cdot \ell_0 / {}_4L_1)$, where ${}_4P_1^*$ is the corrected number of persons 1 to 5 (${}_4P_1$ from the census, multiplied by an adjustment factor), and ${}_4L_1 / 4 \cdot \ell_0$ is the estimated proportion surviving from birth to the age interval 1 to 5 according to the mortality in the years before the census.

(2) ${}_4L_1$ is taken from a "West" model life table (for the two sexes combined) in which ${}_1q_0$ is equal to the average value of the registered infant mortality rate in the governorate for the years in question, adjusted for underregistration as described in Appendix A.

(3) ${}_4P_1^*$ is the enumerated population 1 to 5, multiplied by a factor common to all governorates. This factor is the multiplier required to adjust ${}_4P_1$ for the combined populations of Cairo and Alexandria to yield a reverse projection that matches the number of registered births in the two metropolitan centers combined. In 1976 no adjustment of ${}_4P_1$ was needed; in 1947 a factor of 1.06 was required to bring the

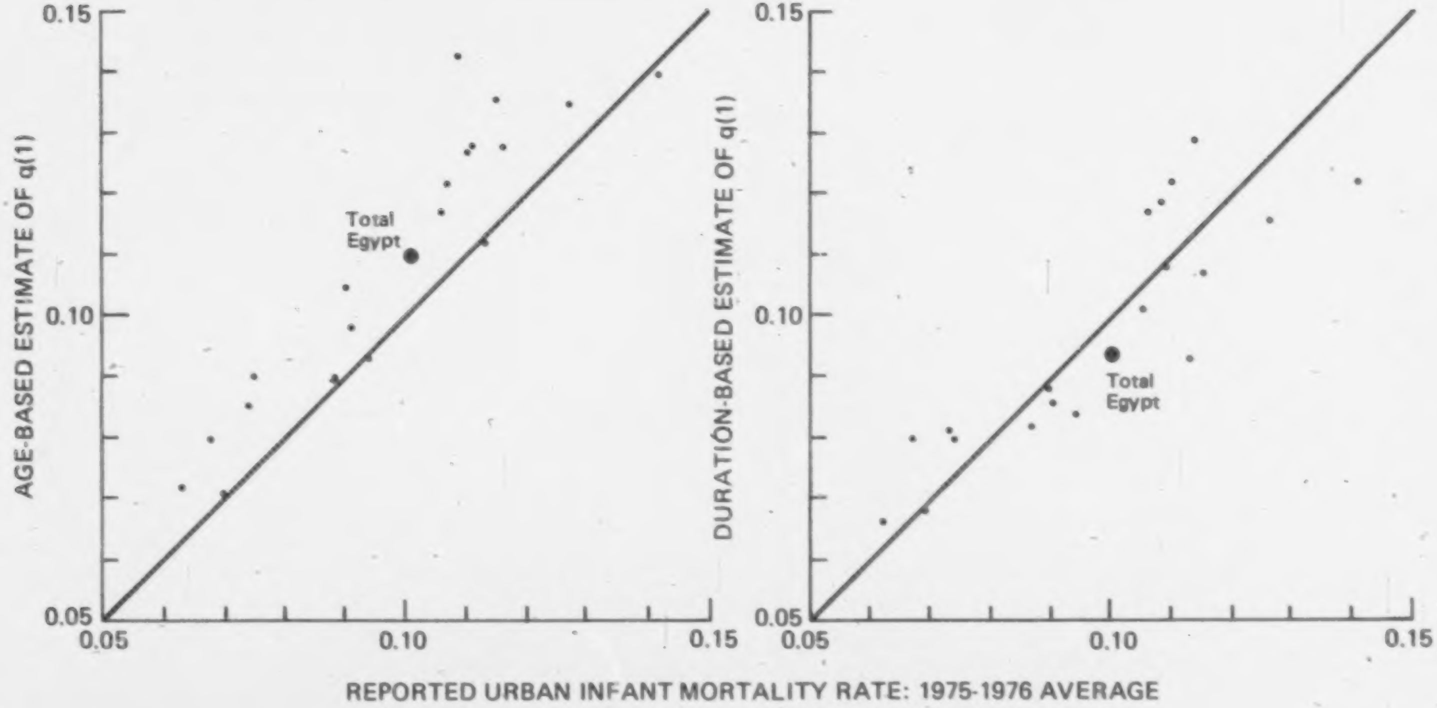


FIGURE A.4 Comparison of Age- and Duration-Based Estimates of q(1) to Average Reported Infant Mortality Rates for Urban Areas of Governorates, 1975-76: Egypt

reverse-projected ${}_4P_1$ in Cairo and Alexandria into line with the number of registered births.

(4) The registered births compared with the reverse-projected ${}_4P_1$ are from the period extending from exactly five years to exactly one year before the census--if no allowance is made for age misstatement in the determination of ${}_4P_1$, or for delay in the registration of births. Children less than 1 year old are almost certainly included in ${}_4P_1$, and children approaching 5 are omitted. The time of birth of the ${}_4P_1$ cohort thus extends from less than one to less than five years before the census, rather than from exactly one to exactly five years. The delay in birth registration in Egypt displaces the recorded time of birth by some unknown fraction of a year toward the date of the census. The 1976 census was taken in November, so registered births in 1972-1975 (from 10 1/2 months to 4 years 10 1/2 months before the census) were judged appropriate for comparison with reverse-projected ${}_4P_1$. For the 1947 census, which was taken in March, births for 1942.5 to 1946.5 were judged to be appropriate for comparison (half of the births registered in 1942 and 1946 were added to the births registered in 1943, 1944, and 1945).

Table B-1 lists estimates of completeness of birth registration by governorate in the 1940s and 1970s, with separate figures for the rural and urban populations in the 1970s. In the 1940s completeness of birth registration in all of the governorates of Upper Egypt except Giza is estimated as 85 percent or less; in all of the lower Egyptian governorates completeness is estimated as 88 percent or more. In the 1970s, urban registered births exceed the estimates from reverse projection of ${}_4P_1$ in several Lower Egypt governorates; the only consequential extent of estimated underregistration is in rural Upper Egypt.

Underregistration of Births in the late 1950s

Estimates of completeness of birth registration by governorate in 1956-59, derived from reverse projection of ${}_4P_1{}^*$ in the 1960 census (September 20), are shown in Table B-2. As for the 1940s and 1970s, values of $4 \cdot \ell_0 / {}_4L_1$ for the reverse projection were obtained from "West" model life tables and corrected infant mortality rates. To match registered births in

TABLE B-1 Estimates of Completeness of Birth Registration in the Governorates Based on Reverse Projection of the Census Population Aged 1-4; 1940s and 1970s: Egypt

Governorates	1940s[a]	Total Governorate	1970s[b] Urban Areas	Rural Areas
Major Metropolitan				
Cairo	1.004	1.015	1.015	-- [c]
Alexandria	0.993	0.977	0.977	-- [c]
Lower Egypt				
Damietta	1.107	1.053	1.149	1.021
Dakahlia	0.917	1.037	1.153	1.007
Sharkia	0.881	0.990	1.042	0.978
Kalyubia	0.919	0.963	0.869	1.026
Kafr-el-Sheik[d]	--	0.925	1.034	0.903
Gharbia	0.930	1.024	1.067	1.006
Menoufia	1.037	1.045	0.934	1.066
Behera	0.901	0.998	1.017	0.993
Ismailia[c]	--	0.743	0.530	0.894
Upper Egypt				
Giza	0.908	0.958	0.950	0.965
Beni-Suef	0.846	0.926	1.043	0.896
Fayoum	0.836	0.887	0.976	0.863
Minya	0.853	0.871	0.992	0.848
Assyiut	0.826	0.887	0.976	0.856
Souhag	0.753	0.940	1.093	0.887
Kena	0.673	0.877	0.957	0.856
Aswan	0.727	0.987	0.826	1.080
Egypt	0.890	0.964	0.993	0.946

[a] Registered births mid-1942 to mid-1946 relative to reverse projection of $_4P_1$ in 1947 census ($_4P_1$ raised by 5.7 percent).

[b] Registered births 1972-75 relative to reverse projection of $_4P_1$ in 1976 census.

[c] No rural areas.

[d] Not a separate governorate in 1947.

Cairo and Alexandria combined, $_4P_1$ was multiplied by 1.025. Also, a special adjustment was made in Cairo, Giza, and Kalyubia, because beginning in 1955 births registered in two districts in Giza and one district in Kalyubia were transferred to Cairo. The 1960 census recorded the population of these districts in Giza and Kalyubia rather than in Cairo. Therefore the registered births in the transferred districts were reallocated to

TABLE B-2 Estimates of Completeness of Birth Registration in 1956-59 by Governorate, Based on Reverse Projection of the 1960 Census Population Aged 1-4: Egypt

Major Metropolitan	
Cairo	1.004
Alexandria	0.992
Lower Egypt	
Damietta	0.836
Dakahlia	0.897
Sharkia	0.905
Kalyubia	0.965
Kafr-el-Sheik	0.696
Gharbia	0.900
Menoufia	1.004
Behera	0.957
Upper Egypt	
Giza	0.830
Beni Suef	0.780
Fayoum	0.850
Minya	0.836
Assyiut	0.716
Souhag	0.668
Kena	0.580
Aswan	0.738
Egypt	0.857

the original governorates before comparison with the reverse-projected ${}_4P_1$.

Estimated completeness of birth registration in the late 1950s is highly correlated with estimated completeness in the 1940s except in the governorates of Damietta, Giza, Beni Suef, Kena, Souhag, and Assyiut. (See Figure B-1; the dots representing the 6 mentioned governorates lie more to the right of the 45 degree line, indicating higher estimated completeness in the 1940s than in the late 1950s.) An examination of annual registered births by governorate, and even by district within governorates, suggests that the low estimated completeness for 1956-59 in these governorates was caused by particularly severe underregistration in 1956 and

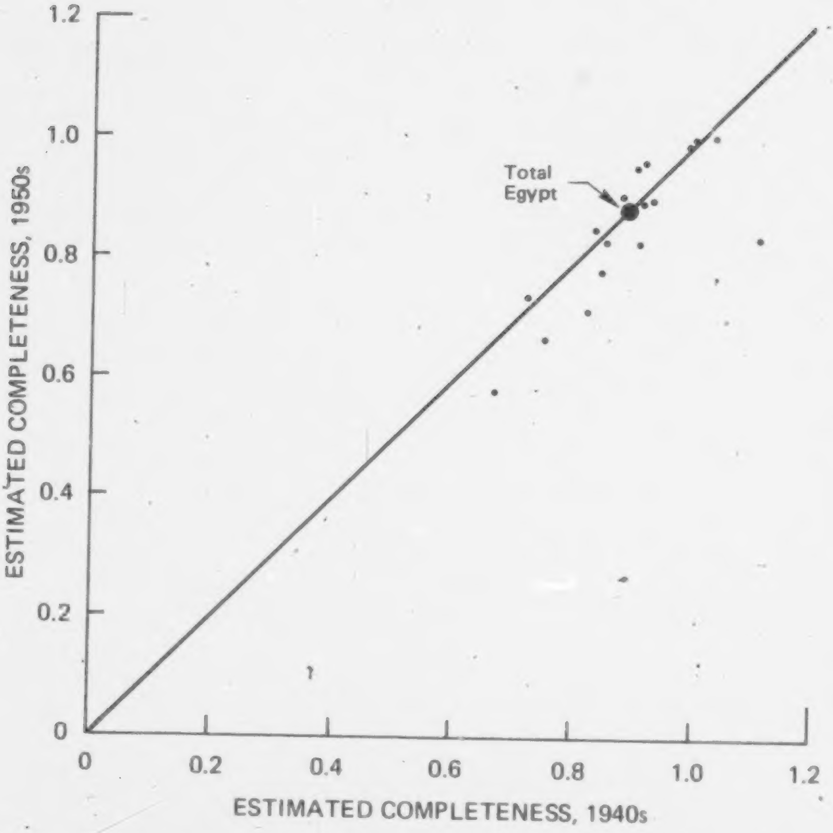


FIGURE B.1 Comparison of the Estimated Completeness of Birth Registration in the Governorates in the 1940s and the 1950s: Egypt

1957, perhaps associated with the Suez crisis. The evidence is in the form of especially low registered birth rates in those two years in the governorates in which estimated completeness was lower in 1956-59 than in 1942-46; and very low birth rates in the districts in the bottom quartile of rates within the governorates. A conspicuous instance is the governorate of Damietta: in Damietta city the birth rate calculated from registered births falls from 46.0 per thousand in 1955 to 16.2 in 1956 and 2.8 in 1957 (only 198 births recorded in a population of 71,000!). Obviously many births were not registered or, if registered, were not recorded in the official vital statistics.

Other indications of severe underregistration of births during the 1950s come from comparing the expected survivors of the cohorts born in the 1950s with census counts in 1960 and 1976. In Table B-3, the population under age 10, as expected from registered births and estimated mortality, is compared with enumerated populations in 1937, 1947, 1960, and 1976. In each

TABLE B-3 Comparison of the Population Estimated from Projected Registered Births and Enumerated in the Census: Egypt

Part A. Population Under 10

Year	Estimated Population, 0-9	Enumerated Population, 0-9	Ratio (Estimated to Enumerated)
1937	4,305	4,316	0.997
1947	4,842	4,985	0.971
1960	7,164	7,931	0.903
1976	9,904	9,724	1.018

Part B. Population 15-24

Year	Estimated Population, 15-24	Enumerated Population, 15-24	Ratio (Estimated to Enumerated)
1960	3,966	3,949	1.004
1976	6,537	7,075	0.924

Note: Births by five-year periods were projected using survival factors taken from female "West" model life tables chosen based on an estimate of q(1). q(1) was assumed to equal the average estimated infant mortality rate for the appropriate five-year period. For 1960 estimates of the population 15-24, mortality level 8 was used for projecting birth cohorts from the age group 5-9 to 15-19 and 20-24 as appropriate. For the 1976 estimates, mortality level 10 was used.

instance except 1960 the estimated population approximately equals the enumerated; if births are underregistered, the undercount of the population is of about the same extent. In 1960, however, the ratio of expected to counted is 7 to 10 percent less than at other dates--a difference caused, it seems clear, by especially large underregistration of births in the 10 years before the 1960 census.

The second section of Table B-3 compares the calculated survivors of births registered in 1936-45 with the enumerated population at ages 15-24 in 1960, and also the calculated survivors of births registered in 1952-61 with the enumerated population at ages 15-24 in 1976. In 1960, the expected population matches the enumerated very closely (again underregistration is apparently balanced by an undercount), but in 1976 the population expected from births registered in 1952-61 falls 8 percent short of the number recorded in the census. Faced with this evidence of especially poor registration in the 1950s, we have assumed a steady increase in the number of births from 1947 to 1960 to provide figures by five-year time periods (for use in the projection), but present no estimates of births by single years.

The evidence of especially acute underregistration of births in 1956 and 1957, at least in some governorates, implies that adjustment of births in 1960 and 1961 for underregistration estimated for 1956-59 would yield estimates that are too large. The adjustments for 1960-61 births are especially important for this report, because the census of 1960, together with corrected numbers of births, makes possible the calculation of refined measures and indexes of fertility for Egypt and its major regions. To avoid misleadingly high estimates of fertility in 1960 by overcorrection (in Damietta, for example), underregistration of births in 1960 in each governorate was estimated as the average of the rates of underregistration for 1942-46 and 1972-75. In short, the estimation of underregistration for 1956-59 obtained by reverse projection of ${}_4P_1$ from the 1960 census was not used as the basis for estimates in other years.

Estimated Births, 1927-76

Because the average birth rate for 1942.5 to 1946.5, adjusted for the extent of underregistration that we estimated, agrees exactly with the average of El-Badry's

(1965) estimates for those years (formed by accepting the Health Bureau birth rates for the urban governorates as estimates for the rates in the urban Health Bureau areas in other governorates, and assigning the birth rate of the rural Health Bureau areas in each governorate to the entire rural population), we accepted El-Badry's estimates for 1934 to 1947 and extended his average correction factor for the 1930s (1.12) back for the years 1927 to 1933. The adjustment applied in 1960 (the average of the adjustments for 1942.5-1946.5 and 1972-75) was 1.08 times registered births. It was assumed that this correction declined linearly from 1960 to 1972. Estimates of births (and birth rates or other fertility measures) for subdivisions of Egypt were attempted only for periods centered on the censuses of 1947, 1960, and 1976. For other years we attempted only to prepare adjusted figures for births and crude birth rates for Egypt as a whole.

CONSTRUCTION OF FERTILITY MEASURES AND INDEXES

Registered births, adjusted for underregistration, were used to create annual estimates of the crude birth rate, 1927-76. (The denominator was obtained by geometric interpolation of the population enumerated in the censuses of 1927, 1937, 1947, 1960, and 1976 to the midpoint of each year.) In Table 4 (in Chapter 2), the general fertility rate, the total fertility rate, and the three fertility indexes (I_f, I_m, and I_g) are shown for the census years from 1937 to 1976. For 1947 these additional measures are given for Cairo plus Alexandria and for the remainder of Egypt; for 1960 the metropolitan populations, Lower Egypt, and Upper Egypt are shown; and for 1976 the rural and urban sectors of the two major regions are represented separately. In this section of Appendix B the methods employed in calculating these additional measures are described.

Before fertility measures for 1960 were calculated for the Cairo, Giza, and Kalyubia governorates, some of the births registered in Cairo were reallocated to the other two governorates to correspond to the geographic division of the population in the census. From 1955 through 1961 births in the El Giza and Embaba districts (originally part of Giza) and the Shubra el Balad district (originally part of Kalyubia) were tabulated with births in Cairo, but in the 1960 census the populations in these districts were counted in their original governorates.

General Fertility Rate

The general fertility rate was calculated by dividing the number of births attributed to the area in question by the enumerated female population aged 15 to 49. I_f, I_m, and I_g were calculated by the standard formulae:

$$I_f = \text{Births}/\sum F_i w_i;$$
$$I_g = \text{Births}/\sum F_i m_i; \text{ and}$$
$$I_m = \sum F_i m_i / \sum F_i w_i,$$

where F_i is the fertility rate in the i^{th} five-year age interval (of the seven from 15-19 to 45-49) of married Hutterites (a population with very high marital fertility); m_i and w_i are, respectively, the number of married women and the number of women in the i^{th} interval (Coale, 1965). In the Egyptian censuses the number married is listed only for women 16 and over; therefore the true number of married women 15-19 may be somewhat understated because of unrecorded married women at age 15.

Total Fertility Rate

The total fertility rate was estimated from the calculated value of I_f. This index is the ratio of the number of births women have to the number they would have if subject to F_i, the schedule of age-specific marital fertility of the Hutterites. If I_f were 1.0, the population in question would have fertility as high, on the average, as the married Hutterite schedule. The total fertility rate this schedule implies is 12.4 births per woman; hence the total fertility rate is calculated as $12.4(I_f)$, an approximation that is quite close in populations (like that of Egypt) in which marriage is early and the age structure of marital fertility is not strongly affected by voluntary control.

Table B-4 lists fertility measures and indexes for the governorates of Egypt in 1960 and 1976 with separate figures for rural and urban populations at the later date. Note that in most of the Upper Egypt governorates (all but Aswan) the value of I_g at both dates is much the same (with the 1976 estimates a little higher), as is also true of Behera and Menoufia in Lower Egypt. Among the remaining governorates, there is a strong correlation between the two values, but with consistently lower I_g (especially in Cairo and Alexandria) in 1976. Figure B-2

TABLE B-4 Measures and Indexes of Fertility by Governorate, 1960 and 1976: Egypt

	Crude Birth Rate	General Fertility Rate	Total Fertility Rate	Index of Overall Fertility I_f	Index of Marital Fertility I_g	Index of Proportion Married I_m	Women 15-49 Divided by Total Population
1960 Total Governorate							
Cairo	42.4	187.9	5.99	0.483	0.669	0.722	.226
Alexandria	39.5	180.0	5.79	0.467	0.673	0.694	.219
Lower Egypt							
Damietta	42.5	197.7	6.40	0.516	0.674	0.765	.215
Dakahlia	46.7	213.9	7.01	0.565	0.731	0.772	.218
Sharkia	50.7	228.1	7.53	0.607	0.764	0.795	.222
Kalyubia	55.2	253.7	8.37	0.675	0.820	0.824	.218
Kafr-el-Sheik	45.5	202.5	6.70	0.540	0.735	0.735	.225
Gharbia							
Menoufia	45.5	209.5	7.14	0.576	0.742	0.777	.217
Behera	43.9	190.4	6.24	0.503	0.692	0.727	.231
Upper Egypt							
Giza	47.7	208.0	6.75	0.544	0.692	0.785	.229
Beni Suef	47.0	192.5	6.44	0.519	0.706	0.735	.244
Fayoum	51.0	219.3	7.23	0.583	0.746	0.781	.233
Minya	51.5	218.5	7.23	0.583	0.754	0.773	.236
Assyiut	48.8	218.6	7.22	0.582	0.775	0.751	.223
Souhag	43.5	189.7	6.27	0.506	0.683	0.741	.229
Kena	45.3	194.3	6.36	0.513	0.648	0.792	.233
Aswan	50.6	211.5	6.94	0.560	0.712	0.789	.239
Egypt	46.3	204.5	6.71	0.541	0.716	0.755	.226

1976 Total Governorate

Cairo	32.1	123.1	3.93	0.317	0.533	0.596	.261
Alexandria	30.3	117.4	3.73	0.301	0.529	0.568	.258
Lower Egypt							
Damietta	35.0	152.2	4.85	0.391	0.585	0.669	.230
Dakahlia	35.9	155.1	5.12	0.413	0.612	0.675	.231
Sharkia	39.7	171.6	5.89	0.475	0.699	0.679	.224
Kalyubia	44.9	201.2	6.53	0.527	0.771	0.684	.223
Kafr-el-Sheik	39.5	169.6	5.57	0.449	0.703	0.638	.233
Gharbia	35.3	150.2	4.95	0.399	0.638	0.626	.235
Menoufia	38.4	175.5	5.88	0.474	0.704	0.674	.219
Behera	39.7	176.0	5.75	0.464	0.680	0.682	.226
Upper Egypt							
Giza	45.0	189.1	6.03	0.486	0.699	0.695	.238
Beni Suef	44.4	197.2	6.57	0.530	0.724	0.732	.225
Fayoum	47.3	220.0	7.28	0.587	0.777	0.755	.215
Minya	46.9	209.0	6.94	0.560	0.781	0.717	.224
Assyiut	43.6	197.7	6.53	0.527	0.746	0.706	.221
Souhag	40.0	175.4	5.83	0.470	0.704	0.668	.228
Kena	42.8	185.4	6.15	0.496	0.662	0.749	.231
Aswan	41.9	176.7	5.82	0.469	0.650	0.721	.237
Egypt	40.5	172.7	5.48	0.442	0.666	0.663	.235

TABLE B-4 (continued)

	Crude Birth Rate	General Fertility Rate	Total Fertility Rate	Index of Overall Fertility I_f	Index of Marital Fertility I_g	Index of Proportion Married I_m	Women 15-49 Divided by Total Population
1976 Urban Areas							
Cairo	32.1	123.1	3.93	0.317	0.533	0.596	.261
Alexandria	30.3	117.4	3.73	0.301	0.529	0.568	.258
Lower Egypt							
Damietta	28.3	113.0	3.70	0.298	0.480	0.622	.250
Dakahlia	30.4	119.4	3.84	0.310	0.516	0.601	.255
Sharkia	37.3	150.8	4.90	0.395	0.659	0.599	.247
Kalyubia	49.1	206.9	6.50	0.524	0.768	0.683	.237
Kafr-el-Sheik	34.7	141.6	4.61	0.372	0.620	0.600	.245
Gharbia	31.7	123.7	3.99	0.322	0.560	0.576	.256
Menoufia	37.5	156.6	5.17	0.417	0.681	0.617	.239
Behera	37.4	155.8	5.05	0.407	0.659	0.612	.240
Upper Egypt							
Giza	41.2	162.2	5.12	0.413	0.647	0.638	.254
Beni Suef	39.5	167.3	5.53	0.446	0.665	0.670	.236
Payoum	42.5	186.5	6.15	0.496	0.724	0.685	.228
Minya	38.6	165.3	5.38	0.434	0.697	0.622	.234
Assyiut	37.9	164.8	5.42	0.437	0.713	0.613	.230
Souhag	40.3	177.1	5.78	0.466	0.739	0.631	.228
Kena	44.7	192.1	6.32	0.510	0.743	0.687	.233
Aswan	41.1	172.2	5.52	0.445	0.623	0.714	.239
Egypt	37.8	150.5	4.60	0.371	0.609	0.609	.251

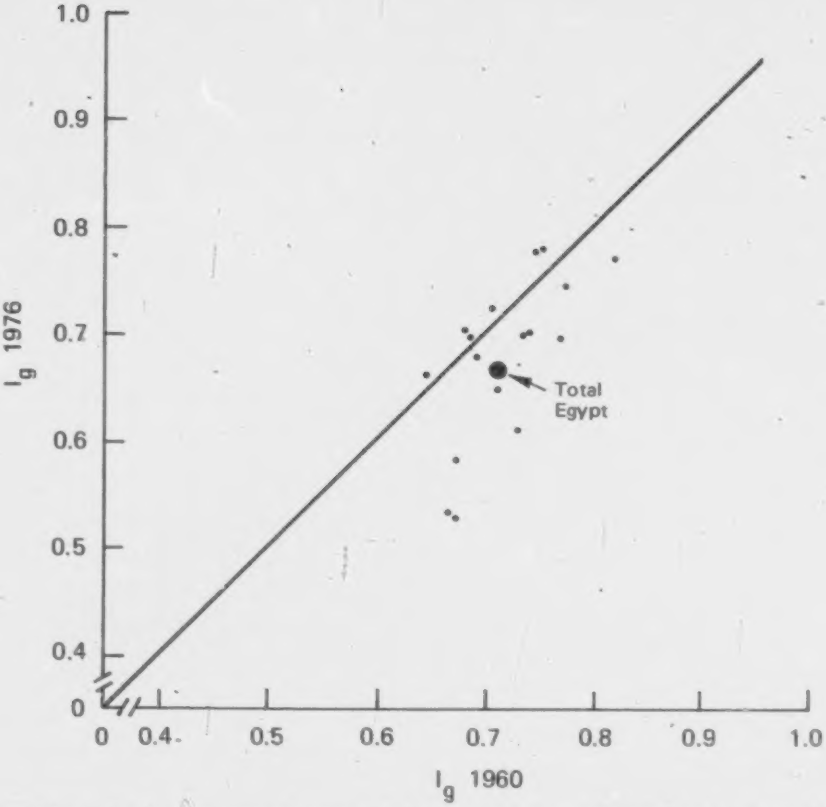


FIGURE B.2 Comparison of the Index of Marital Fertility (I_g) in 1960 and in 1976 for the Governorates: Egypt

shows this correlation in a comparison of the values of I_g in 1960 and 1976 in the governorates.

CAPMAS ESTIMATE OF COMPLETENESS OF BIRTH REGISTRATION IN THE 1970S

Independent estimates of underregistration of births have been obtained in the 1974-75 vital events survey by CAPMAS (see Appendix F). In Table B-5 these estimates are compared with those obtained by reverse survival. As with infant mortality underregistration, the survey-based estimates are uniformly higher than those based on reverse survival. It is likely that our reverse survival procedure understates underregistration because we chose

TABLE B-5 Estimates of Underregistration of Births in the 1970s by Major Regions: Egypt

Region	Underregistration of Births 1974-75, CAPMAS Survey	 1972-75, Reverse Survival of Census Population Aged 1-4
Cairo and Alexandria	.023	-.004
Urban Lower Egypt	.053	.004
Urban Upper Egypt	.093	.025
Rural Lower Egypt	.110	.003
Rural Upper Egypt	.244	.112

not to adjust the 1976 ${}_4P_1$, since reverse projection without adjustment so closely matched registered births in Cairo and Alexandria. Registered births in urban Damietta, Dakahlia, and Gharbia are well in excess of the reverse-projected numbers; based on these governorates, an upward adjustment of ${}_4P_1$ by 3 or 4 percent would be justifiable, adding 3 or 4 percent to all estimates of underregistration. But the difficulties of establishing a true match between survey-recorded and registered births establishes the possibility of an overestimate of underregistration from the survey.

We have chosen to retain the possibly low estimates of underregistration based on reverse projection to maintain better consistency with estimates described earlier.

Appendix C

Estimation of Mortality (Other than Infant and Child Mortality)

This appendix adapts a recently developed method for estimating the completeness of registration of deaths above age 10 for application to registered male and female deaths in Egypt for every year from 1937 to 1976.

The method is applicable to populations in which no major sustained changes in fertility began more than 15 or 20 years before the year for which the estimate is made. Since our estimates show no continued decline (or increase) in fertility in Egypt before the 1960s, the method seems suitable in this context. Because the basic relation upon which the method depends is a relation characteristic of stable populations, it might appear that approximately constant mortality is also an essential condition, but in practice the estimates are only slightly affected by recent trends in mortality (Preston et al., 1980; an earlier approach can be found in Carrier, 1958).

ESTIMATING COMPLETENESS OF DEATH REGISTRATION

It can be shown that in a stable population, the number of persons at age a, $N(a)$, equals the sum of the number of deaths at each higher age x, $D(x)$, multiplied by $\exp(r(x-a))$, where r is the population's rate of growth. Call the number calculated in this way $\hat{N}(a)$. Thus,

$$\hat{N}(a) = \sum_{x=a}^{\omega} D(x) \exp(r(x-a)).$$

The number of persons by five-year age intervals can also be determined from r and the number of deaths, as ${}_5\hat{N}_a = 2.5\,(\hat{N}(a) + \hat{N}(a+5))$; and the sum of ${}_5\hat{N}_x$'s for all ages above a is the estimated number at ages a and over, $\hat{N}(a+)$. In a stable population with a known growth rate, $\hat{N}(a+)/N(a+)$ is the same for all ages, except for inaccuracies in the data--this ratio is equal to 1.0 if deaths are completely recorded, and equal to C, the relative completeness of the recording of deaths compared to the population, if deaths are not completely recorded.

If the $\hat{N}(a+)/N(a+)$ method of estimating completeness of death registration is applied to Egyptian data (i.e., to the number of deaths registered at different ages in a given year, and to the number of persons in different age intervals interpolated from appropriate censuses), the estimates consistently indicate that deaths are very much more than fully registered. The extent of apparent overregistration (i.e., $\hat{N}(a+)/N(a+)$) rises steadily with age (see Figure C-1 for an example).

Persistent overregistration of deaths is not believable, but another explanation, overstatement of age at death, may be possible. A frequent faulty characteristic of mortality data in populations that cannot supply precise data on age is overstatement of age at death, particularly at advanced ages. Such overstatement causes artificially high values of $\hat{N}(a+)/N(a+)$ at all ages, and rising values of $\hat{N}(a+)/N(a+)$ with age. For example, suppose that reported deaths have been transferred from younger ages to over 80. Recall that

$$\hat{N}(a) = \sum_{x=a}^{\omega} D(x) \exp(r(x-a)).$$

Having too many deaths over age 80 leads directly to too large a value of $\hat{N}(80)$ but also (less directly) increases $\hat{N}(a)$ at younger ages as well (when the growth rate is positive). The exaggeration of $\hat{N}(a)$ at all younger ages (and hence of $\hat{N}(a+)$) results from exaggeration of x in the exponential factor $\exp(r(x-a))$ that multiplies $D(x)$ in the calculation of $\hat{N}(a)$. The persistent appearance in calculations for Egypt of $\hat{N}(a+)/N(a+)$ that is always greater than 1.0, and that rises to very high values (over 3.0) at ages 75 and above is consistent with extensive overstatement of age at death.

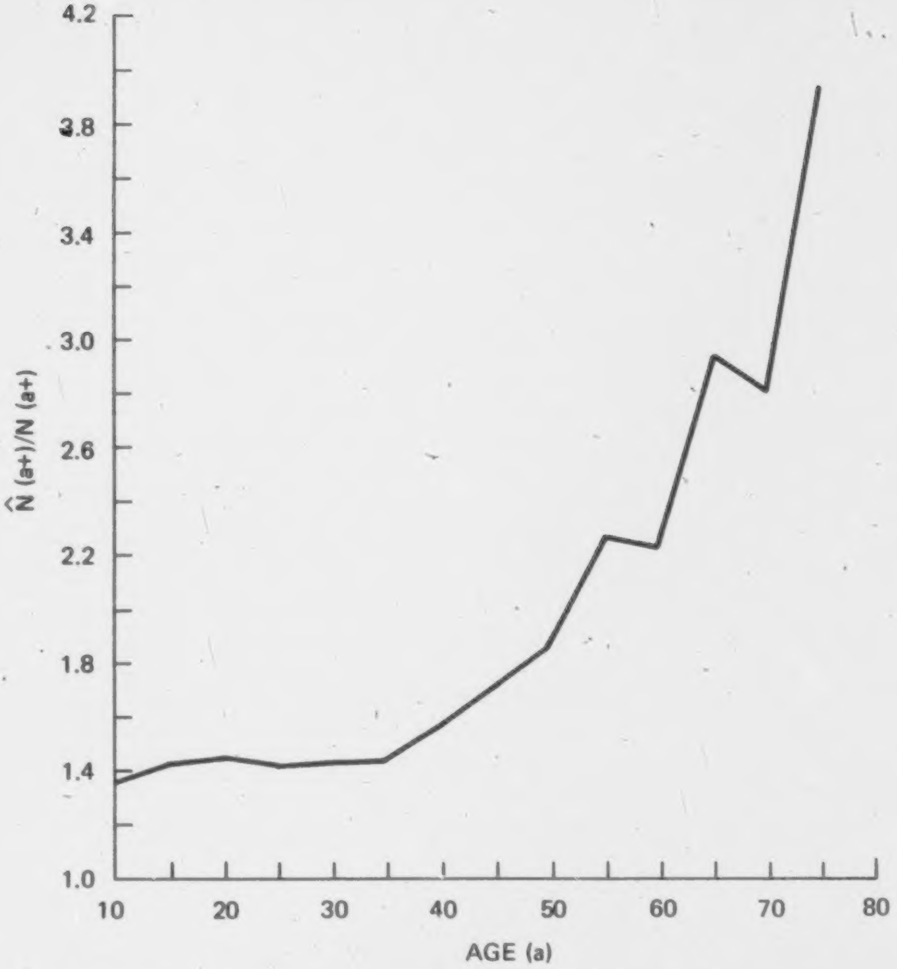


FIGURE C.1 Completeness of Death Registration Estimated by Comparison of Deaths and Population at Age (a) and Over, Males, 1941-42: Egypt

ESTIMATING THE NATURE AND EXTENT OF FALSE REPORTS OF AGE AT DEATH AT VERY HIGH AGES

The possibility that overstatement of age at death is the cause of the progressively rising estimates of over-registration of deaths in Egypt led to a comparison of the distribution of deaths by age with a standard that approximates the true distribution. The standard chosen was a "South" model stable population incorporating the broad overall steepness of the recorded age distribution (as interpolated between censuses) and the estimated rate of increase. "Overall steepness" was calibrated by the ratio (population 10 to 50)/(population 10+). At this point the comparison and analysis for males in 1941-42 will be described; a similar comparison was made for every year for males and females. Two pairs of cumulative proportionate distributions are compared in Figure C-2: one pair of cumulative distributions of the population by age and one pair of cumulative distributions of deaths by age, all beginning at age 10. Each pair of distributions compares the distribution from Egyptian data with the corresponding distribution in the approximately matching stable population.

The cumulative age distribution of the Egyptian population is fairly closely fitted by the stable population, but the cumulative distribution of deaths differs markedly from the stable as early as age 20, and by a widening margin. The slight differences between the cumulative age distribution of the population and the corresponding stable population are explained by the defects in the recorded population. The deficits at ages 15 to 35 in the recorded population create a gap between its cumulative proportionate distribution and that of the corresponding stable figure that reaches a maximum at age 35; then the two cumulative distributions converge.

In sharp contrast is the ever widening gap between the cumulative distribution of recorded deaths and the corresponding stable distribution. The gap can hardly be explained by an inappropriate choice of the stable distribution of deaths, given the close fit to the recorded age distribution of the stable population incorporating exactly the same distribution of deaths. The fault must lie with the recorded proportionate distribution of deaths.

One might suppose that the high proportion of deaths over 80--more than three times the proportion in the stable population--is explained by a tendency for age at death to be overstated for older decedents. Suppose such overstatement began at age 50. Only above age 50 would the gap between the cumulative distributions begin. The existence of the gap virtually from age 10 suggests either a substantial incidence of overreported ages at death at all ages or some form of direct transfer of reported deaths from all ages to the highest category.

Figure C-3 illustrates, for five-year age groups from age 10-75, the ratios of the proportion of persons and deaths in Egypt to the proportions found in the stable

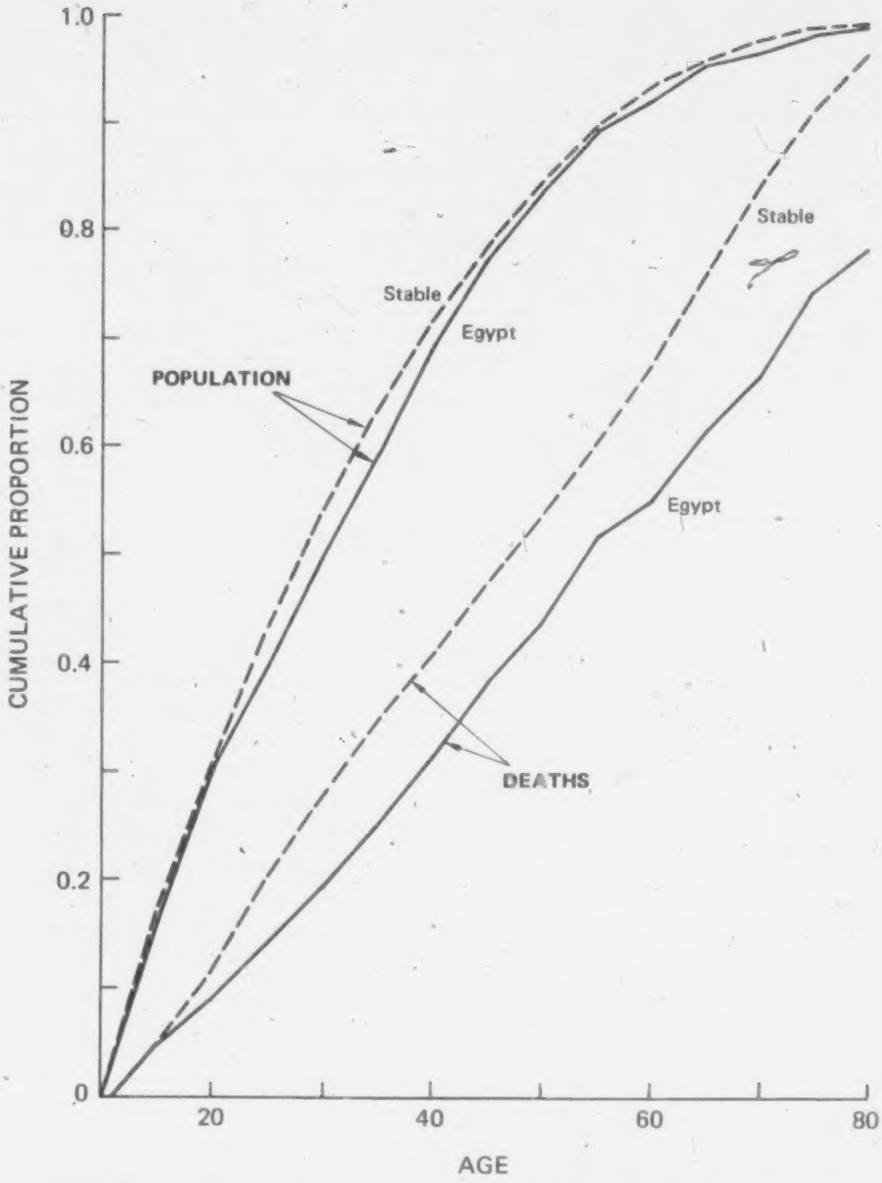


FIGURE C.2 Cumulative Proportionate Distribution of Population and Deaths at Ages 10 and Over, Males, 1941-42, and for a "South" Model Stable Population: Egypt

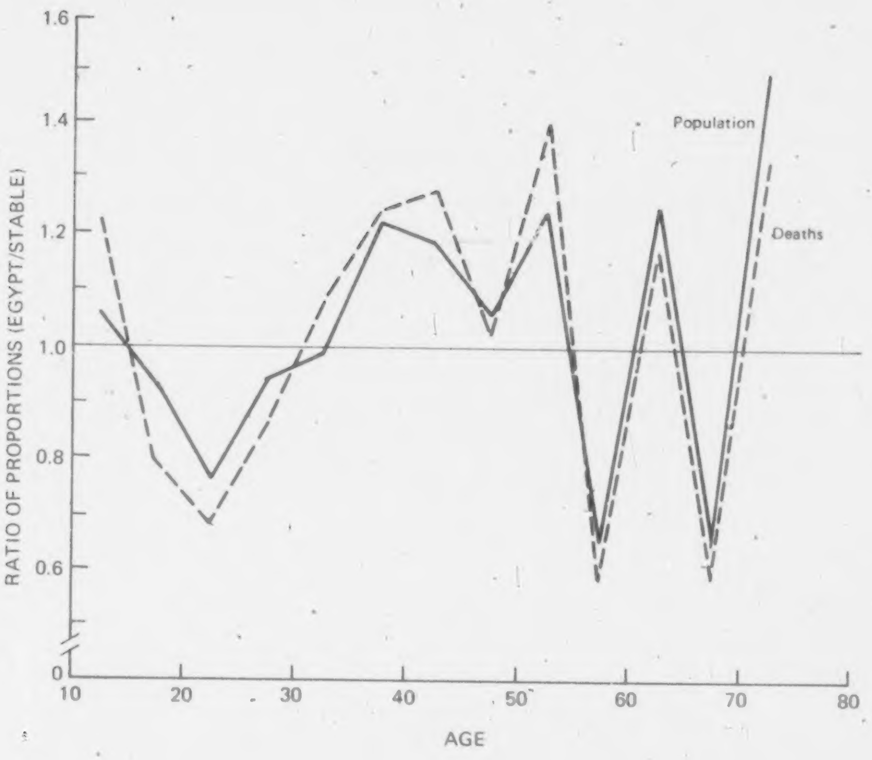


FIGURE C.3 Proportion of Population and Deaths Within the Age Interval 10 to 75 in each Five-Year Age Group Divided by the Corresponding Proportion in a Model Stable Population, Males, 1941-42: Egypt

population. The similarity of the deviations of the proportions of persons and of deaths from the stable is very evident. Apparently the same distortions--primarily the effect of age misreporting--affect the recording of persons in the census and of deaths in the register. The deviations are, however, generally somewhat greater for the reported distribution of deaths. The similarity of the patterns offers no basis for believing that age at death is consistently overstated to a greater extent than age of living persons between the ages of 10 and 75. (There is a slight extra deficit in the distribution of deaths from 50 to 75, relative to the distribution of the population, but surely not enough to account for the very large excess in the proportion of deaths over 75.) Thus, we are left with the possibility that in some way age at death is reported as above 75 or 80 for decedents whose true age is very much less.

How can there be about three times too many deaths recorded at ages over 75 when there is no special pattern of apparent omission in the preceding 25 years? A possible explanation of the large excess number of deaths reported at very advanced ages is the allocation to the oldest ages of deaths at all ages (except infancy and childhood) in which the age of the decedent is unknown. The very extensive age heaping in Egyptian censuses and the repetitive pattern from census to census of distorted age distributions by five-year intervals make it evident that age is not known for a large fraction of the Egyptian population. It seems probable that ages of the dead are known even less frequently than ages of the living; the greater departures of the distribution of deaths than the distribution of the living from the stable distribution from ages 10 to 75 (Figure C-3) lends some support to this conjecture. Yet the proportion of deaths recorded as "age unknown" is very small. It appears that registrars feel pressed to avoid an entry of "age unknown"; if the practice has developed of assigning deaths of unknown ages to the modal category for adult deaths, the excess number of deaths reported at the highest ages would be the result of deaths being transferred up from the whole range of ages above childhood.

Provisionally accepting this explanation of the over-reporting of deaths at the highest ages, we estimated the excess at the highest ages by assuming that the proportion of deaths over 70 should be the same as in a "South" model stable population with the same death rate over age 10 and the same rate of increase. This assumption led to estimates that 46.7 percent of male deaths in 1941-42 were improperly reported as occurring over age 70. This fraction of excess deaths was removed from the over-70 age group and transferred to the age range 10-70 by making an appropriate uniform proportioned increase in the number of deaths at each age.

The values of $\hat{N}(a+)/N(a+)$ calculated after these transfers are shown in Figure C-4. The pattern is a convincing vindication of the transfer of deaths from 70+ to 10-70, i.e., for most ages the value of $\hat{N}(a+)/N(a+)$ lies close to the horizontal line $\hat{N}(a+)/N(a+) = 1.0$. The low value of $\hat{N}(70+)/N(70+)$ can be explained by the overstatement of the number of males over 70 in 1937 and 1947. The fraction of the population 10+ that was over

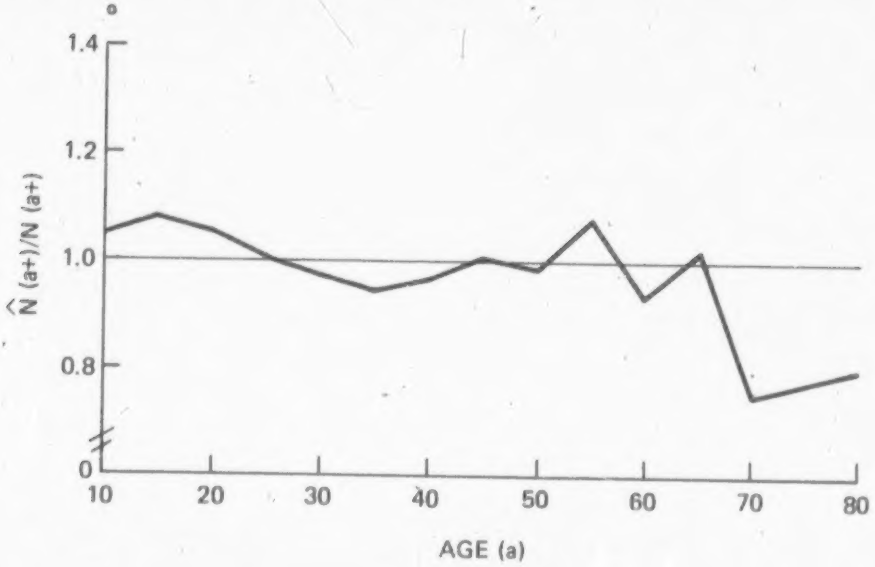


FIGURE C.4 Completeness of Death Registration Estimated by Comparison of Deaths and Population at Age (a) and Over, After Reallocation of Excess Deaths at Age 70 and Over, Males, 1941-42: Egypt

70 is 1.8 percent in the stable population, and 3.0 percent in the average of the 1937 and 1947 censuses. After the deaths at ages 70+ have been corrected for overstatement, the number of persons aged 70+ estimated from the deaths falls short of the overstated number recorded in the censuses.

With this clue about the erroneous transfer of age at death at hand, we established a procedure for reallocating wrongly reported deaths from 70+ to the age range 10 to 70. For each year an estimate of the growth rate of the adult population was established, namely, the average rate of natural increase of the whole population during a period 5 to 15 years earlier. The rate of natural increase was taken from El-Badry's adjusted figures of birth and death rates for 1934 to 1959 (El-Badry, 1965). Rates of natural increase were estimated for earlier and later years by assuming that the understatement of birth and death rates prior to 1934 was as in the earliest years of El-Badry's estimates, and after 1960 as in the last years of El-Badry's estimates. (The approximate validity of these rates of natural increase is supported by their aggregate agreement with intercensal population increase. A rate of natural increase in each year $\underline{t}$ implies a cumulated increase in T years of

$$e^{\sum_{0}^{T} r(t)}$$

The populations enumerated in 1937, 1947, 1960, and 1976 differ from the populations calculated from the 1927 census and cumulated rates of natural increase by -3.8 percent, 0.5 percent, 1.2 percent, and 2.3 percent respectively.)

The next step was to determine, by interpolation between censuses, the approximate ratio (persons (10-50))/(persons (10+)) for males and females each year. Then a model stable population ("South" family) was found embodying this ratio of ${}_{40}P_{10}/P(10+)$ and the estimated rate of increase. The ratio of deaths 70+ to deaths 10+ in this stable population was assumed to be the correct proportion. The recorded number of deaths at age 70+ in excess of this fraction was added pro rata to the deaths at each five-year age interval 10-14 to 65-69. Then $\hat{N}(a+)$ was calculated from these reassigned deaths as follows (Preston et al., 1980):

(1) $\hat{N}(70) = D(70+)(1 + r \cdot e(70))$, where $e(70)$ is the expectation of life at age 70 in the model life table selected on the basis of r and ${}_{40}P_{10}/P(10+)$

(2) $\hat{N}(70+) = \hat{N}(70)e(70)(1 - \frac{2r}{3} e(70))$

(3) $\hat{N}(a) = \hat{N}(a + 5)\exp(5r) + {}_5D_a\exp(2.5r)$, for a = 65, 60, 55, . . . , 10; where ${}_5D_a$ is the number of registered deaths from age a to a + 5

(4) ${}_5\hat{N}_a = 2.5(\hat{N}(a) + \hat{N}(a+5))$

(5) $\hat{N}(a+) = \sum_{x=a}^{65} {}_5\hat{N}_x + \hat{N}(70+)$

In Table C-1, the following quantities are listed for each year 1937 to 1976, for males and females: the proportion ${}_{40}P_{10}/P(10+)$; the rate of natural increase, r; the expectation of life at age 10 and at age 70 in the stable population chosen by means of these quantities; and the ratio of deaths at ages 70+ to deaths at ages 10+ as registered and as in the stable population. The last two quantities determine how many deaths are transferred from the 70+ category to the ages from 10 to 70.

The apparent excess proportion of deaths recorded as occurring at ages over 70 is shown in Figure C-5. The ratios (recorded proportion)/(estimated proportion) follow more or less parallel curves for males and females. By this calculation, the proportion of female deaths recorded as over age 70 was more than double the correct proportion from 1937 to 1956 (with the exception of 1947); for the same years the proportion of male deaths was at least 1.75 times the proportion calculated as correct. From the mid 1950s to the early 1960s, overstatement of the proportion of female deaths over age 70 declined from 2.0 times to about 1.5 times the calculated correction proportion; overstatement of the proportion of male deaths over age 70 had apparently been eliminated by the mid 1960s.

Indeed from 1966 to 1974 the calculations imply too small a proportion of male deaths at the higher ages. This anomaly illustrates the limitations of the procedure for estimating the correct distribution of deaths. It is unlikely that too small a proportion of male deaths were recorded as over 70, while the proportion of female deaths over 70 continued to be overstated by a large margin. The model distribution of deaths by age is doubtless somewhat inappropriate in particular periods because the age distribution is not truly stable, because the rate of increase employed is possibly not the proper one, or because the pattern of mortality in Egypt does not follow the "South" model very closely. In our estimation of mortality past age 5, a uniform adjustment for underregistration is applied each year in the period 1960 to 1976 (no adjustment for male deaths, multiplication by 1.18 for females); the values for expectation of life at age 5 and age 10 are from a "South" model table that yields the adjusted death rate over 10. In other words, the anomalous indications of too low a proportion of reported deaths over 70, and the associated indications of over-registered deaths, do not enter the calculations.

In Figure C-6, the values of $\hat{N}(a+)/N(a+)$ calculated as described above are plotted for selected years. Once the apparent excess proportion of deaths over 70 has been corrected by a transfer to younger ages, $\hat{N}(a+)/N(a+)$ no longer indicates a high degree of overregistration (in most years), nor does it any longer rise with age to very high values at older ages. Instead, there is a remarkably similar pattern from year to year, with slightly higher and lower values at the same ages, but with different overall levels from year to year.

1976 Rural Areas			
Cairo	--	--	-
Alexandria	--	--	-
Lower Egypt			
Damietta	37.2	165.0	5.
Dakahlia	37.7	168.3	5.
Sharkia	40.4	185.3	6.
Kalyubia	42.0	196.8	6.
Kafr-el-Sheik	40.7	177.1	5.
Gharbia	37.2	165.8	5.
Menoufia	38.6	180.8	6.
Behera	40.5	183.3	6.
Upper Egypt			
Giza	49.9	230.0	7.
Beni Suef	46.1	208.1	6.
Fayoum	48.7	230.8	7.
Minya	49.1	221.3	7.
Assyiut	45.8	211.4	7.
Souhag	40.0	175.3	5.
Kena	42.2	183.2	6.
Aswan	42.4	179.7	6.
Egypt	42.6	192.2	6.

Note: Ismailia Governorate not included; data n
indexes.

--	--	--	--
--	--	--	--
0.429	0.616	0.697	.226
0.451	0.643	0.702	.224
0.496	0.706	0.704	.218
0.528	0.772	0.684	.213
0.468	0.725	0.646	.230
0.444	0.681	0.652	.224
0.491	0.711	0.691	.214
0.485	0.688	0.705	.221
0.601	0.770	0.781	.217
0.562	0.740	0.760	.222
0.617	0.791	0.780	.211
0.592	0.804	0.736	.222
0.569	0.759	0.750	.217
0.470	0.699	0.673	.228
0.491	0.640	0.767	.230
0.486	0.666	0.729	.236
0.506	0.712	0.711	.222

available to calculate most measures and

TABLE C-1 Measures Used in Reallocation of Excess Deaths at Age 70 and Over: Egypt

	$\frac{{}_{40}P_{10}}{P_{10+}}$	r	e_{10}^{a}	e_{70}^{a}	Registered $\frac{D_{70+}}{D_{10+}}$	Stable Population $\frac{D_{70+}}{D_{10+}}$
Males						
1937	.8384	.0173	45.41	7.27	.3297	.1885
1938	.8384	.0172	45.32	7.25	.3338	.1876
1939	.8384	.0169	45.08	7.21	.3302	.1851
1940	.8384	.0166	44.87	7.18	.3350	.1834
1941	.8384	.0164	44.70	7.15	.3250	.1819
1942	.8384	.0163	44.60	7.14	.3308	.1811
1943	.8384	.0163	44.57	7.13	.3260	.1808
1944	.8384	.0162	44.53	7.12	.3177	.1804
1945	.8384	.0157	44.08	7.05	.3128	.1761
1946	.8384	.0154	43.83	7.01	.3060	.1736
1947	.8384	.0149	43.45	6.95	.2730	.1706
1948	.8375	.0144	43.19	6.90	.3181	.1693
1949	.8367	.0143	43.29	6.92	.3219	.1711
1950	.8358	.0143	43.45	6.94	.3526	.1732
1951	.8350	.0144	43.67	6.98	.3663	.1759
1952	.8341	.0150	44.30	7.09	.3602	.1829
1953	.8332	.0156	44.90	7.18	.3685	.1892
1954	.8324	.0161	45.48	7.28	.3783	.1959
1955	.8315	.0171	46.54	7.45	.3820	.2074
1956	.8307	.0182	47.69	7.64	.3884	.2205
1957	.8298	.0200	49.65	7.94	.4043	.2438
1958	.8290	.0211	51.13	8.16	.3951	.2634
1959	.8281	.0222	52.55	8.38	.4091	.2838
1960	.8270	.0230	53.72	8.58	.4022	.3027
1961	.8272	.0238	54.64	8.73	.4044	.3170
1962	.8274	.0236	54.34	8.68	.3627	.3116
1963	.8276	.0238	54.56	8.72	.3599	.3151
1964	.8278	.0244	55.17	8.82	.3586	.3247
1965	.8281	.0245	55.25	8.83	.3271	.3256
1966	.8283	.0248	55.56	8.89	.3173	.3309
1967	.8285	.0244	55.03	8.80	.3020	.3214
1968	.8287	.0248	55.49	8.88	.2977	.3290
1969	.8289	.0250	55.67	8.91	.2932	.3320
1970	.8291	.0255	56.27	9.02	.3111	.3421
1971	.8294	.0256	56.36	9.03	.3068	.3435
1972	.8296	.0261	56.91	9.14	.3243	.3537
1973	.8298	.0259	56.56	9.07	.3283	.3466
1974	.8300	.0255	55.98	8.97	.3225	.3359
1975	.8302	.0248	55.14	8.82	.3173	.3209
1976	.8308	.0242	54.34	8.68	.3199	.3077

TABLE C-1 (continued)

	$\frac{{}_{40}P_{10}}{P_{10+}}$	r	e_{10}^{a}	e_{70}^{a}	Registered $\frac{D_{70+}}{D_{10+}}$	Stable Population $\frac{D_{70+}}{D_{10+}}$
Females						
1937	.8229	.0173	47.15	7.49	.4695	.2282
1938	.8230	.0172	47.01	7.46	.4804	.2266
1939	.8231	.0169	46.70	7.40	.4798	.2232
1940	.8232	.0166	46.46	7.35	.4920	.2202
1941	.8233	.0164	46.25	7.31	.4836	.2176
1942	.8235	.0163	46.13	7.29	.4938	.2160
1943	.8236	.0163	46.07	7.28	.4701	.2151
1944	.8237	.0162	46.00	7.26	.4620	.2142
1945	.8238	.0157	45.45	7.16	.4634	.2085
1946	.8239	.0154	45.15	7.10	.4615	.2052
1947	.8241	.0149	44.72	7.02	.3987	.2001
1948	.8236	.0144	44.37	6.95	.4777	.1968
1949	.8231	.0143	44.40	6.95	.4758	.1977
1950	.8226	.0143	44.49	6.97	.4935	.1992
1951	.8221	.0144	44.66	7.00	.4988	.2017
1952	.8216	.0150	45.27	7.13	.4947	.2092
1953	.8211	.0156	45.87	7.24	.5051	.2157
1954	.8206	.0161	46.42	7.35	.5221	.2228
1955	.8201	.0171	47.50	7.55	.5262	.2357
1956	.8196	.0182	48.67	7.78	.5414	.2503
1957	.8190	.0200	50.68	8.16	.5533	.2779
1958	.8185	.0211	52.21	8.42	.5483	.3001
1959	.8180	.0222	53.69	8.68	.5576	.3234
1960	.8173	.0230	54.86	8.91	.5401	.3438
1961	.8178	.0238	55.82	9.09	.5580	.3598
1962	.8183	.0236	55.43	9.01	.5402	.3520
1963	.8187	.0238	55.61	9.05	.5504	.3546
1964	.8192	.0244	56.21	9.17	.5543	.3651
1965	.8197	.0245	56.22	9.17	.5432	.3647
1966	.8201	.0248	56.52	9.23	.5453	.3693
1967	.8206	.0244	55.87	9.10	.5367	.3567
1968	.8211	.0248	56.31	9.19	.5271	.3642
1969	.8215	.0250	56.45	9.21	.5330	.3660
1970	.8220	.0255	57.03	9.33	.5568	.3762
1971	.8225	.0256	57.07	9.34	.5450	.3763
1972	.8230	.0261	57.59	9.45	.5559	.3862
1973	.8234	.0259	57.15	9.36	.5555	.3766
1974	.8239	.0255	56.46	9.22	.5382	.3628
1975	.8244	.0248	55.49	9.02	.5311	.3443
1976	.8247	.0242	54.55	8.84	.5271	.3280

[a] Expectation of life in South Model Stable Population chosen on the basis of ${}_{40}P_{10}/P_{10+}$ and r.

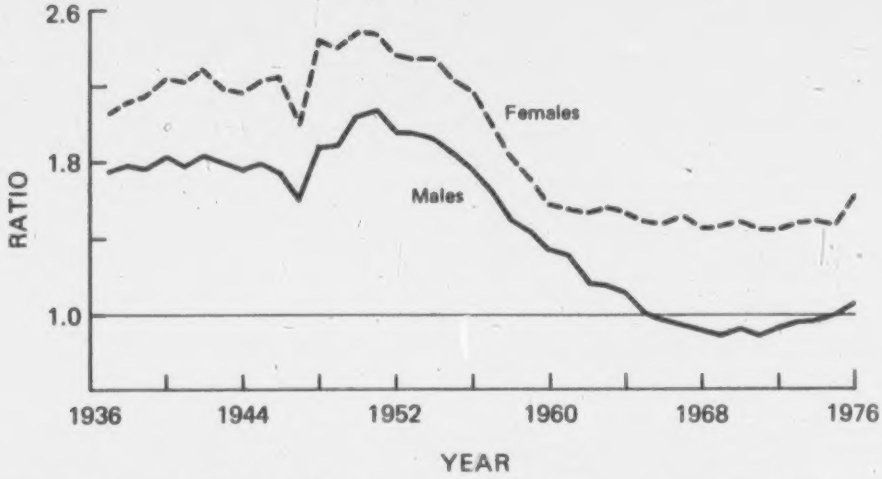


FIGURE C.5 Ratio of the Recorded Proportion of Deaths Over Age 70 to the Estimated Proportion of Deaths Over Age 70, Males and Females, 1937-76: Egypt

The common pattern of the sequence can be explained by the tendency for $\hat{N}(a+)$ (as calculated) to approximate the structure of N(a+) in the stable population used to determine the correct proportion of deaths over 70, and by the consistent resemblance of the Egyptian age distribution, (especially the distribution above age 10), to a stable population. Note in Table C-1 the limited change from year to year in the ratio ${}_{40}P_{10}/P(10+)$; as lower mortality produced a tendency for the age distribution to fall less rapidly with age, a higher rate of increase had an offsetting tendency to make the distribution steeper. Overall, the steepness remains almost constant.

When the number of deaths is redistributed so that the proportion of deaths over 70 to those over 10 matches the proportion in a stable population, the cumulative distribution of deaths over 10 is forced into rough agreement with the cumulative distribution of deaths in the stable population. When $\hat{N}(a+)$ is calculated from this adjusted distribution of deaths and the rate of increase of the stable population, the distribution of $\hat{N}(a+)$ is bound to have a general resemblance to the stable age distribution. Recall that the distribution of deaths within the age interval 10 to 70 in 1941-42 bore much the same relation to the stable distribution of deaths as the distribution of population in the same interval bore to the stable age distribution (Figure

C-3). Since $\hat{N}(a+)$ is the cumulation of $\hat{N}(x)$ above age *a*, the bumps and hollows in the distribution of deaths are smoothed out. Thus each year the structure of $\hat{N}(a+)$ is more or less constrained to resemble a stable age distribution with the current ${}_{40}P_{10}/P(10+)$ and thus bears a more or less fixed relation to the age distribution of the population.

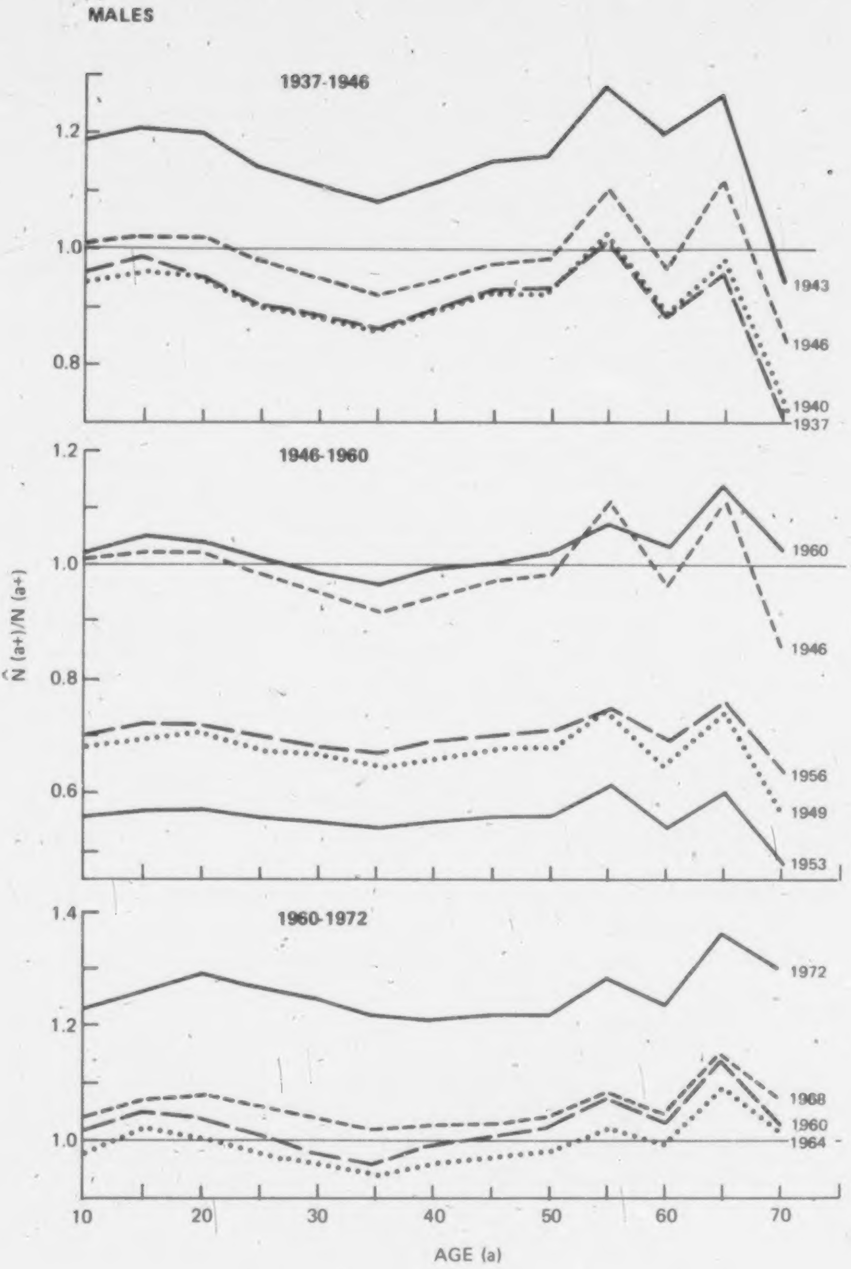
Note that the slight ups and downs of $\hat{N}(a+)/N(a+)$ for different years have a very similar structure, but that the variation with age becomes less over time from 1937 to 1976. The reason is that $\hat{N}(a+)/N(a+)$ departs from a level track primarily because $N(a+)$ deviates from a stable population as age misreporting distorts the distributions reported in the censuses. The pattern of such misreporting remains about the same from census to census but becomes less severe in the more recent censuses.

Although reassignment of deaths from 70+ to other ages more or less insures that the sequence of $\hat{N}(a+)/N(a+)$ is much more nearly level than it is without reassignment, the height of the nearly level sequence still depends on the number of registered deaths relative to the number of persons in the population. The height of the plateau of $\hat{N}(a+)/N(a+)$ can be accepted as an estimate of the completeness of death registration relative to the completeness of enumeration of the population.

Figure C-7 shows the value of $\hat{N}(10+)/N(10+)$ for each year from 1937 to 1976. (The consistency of the sequences of $\hat{N}(a+)/N(a+)$ from year to year allows us to represent each sequence by the value at age 10.) Note that the male and female sequences are very similar, with the apparent completeness of death registration consistently lower for females.

We can conclude from Figure C-7 that there were three periods with differing characteristic degrees of completeness of death registration. From 1937 to 1946, completeness of registration was high for males (about 95 percent complete) and about 15 percent lower for females. Then from 1947 until 1959, completeness of registration for both sexes deteriorated to about 60 percent for males and less than 50 percent for females. After 1959, there was a recovery, so that from 1960 to 1976 male death registration was essentially complete and female registration about 85 percent complete.

Values of $\hat{N}(10+)/N(10+)$ of more than 1.0 for males in some years in the 1940s and around 1970 require explanation. This system of estimating completeness of


MALES
1937-1946
1.2
1.0
0.8
1943
1946
1940
1937
1946-1960
1.2
1.0
0.8
0.6
1960
1946
1956
1949
1953
1960-1972
1.4
1.2
1.0
1972
1968
1960
1964
N̂ (a+)/N (a+)
10
20
30
40
50
60
70
AGE (a)

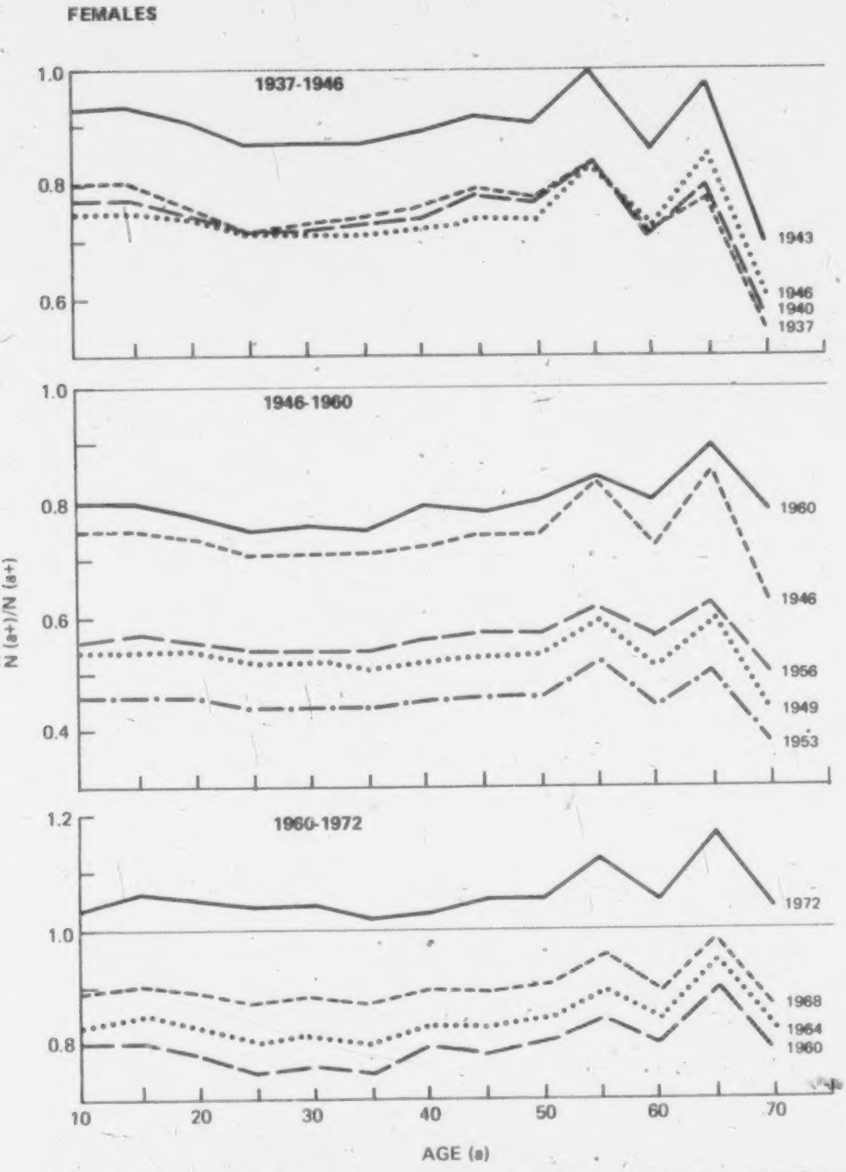


FIGURE C.6 Completeness of Death Registration Estimated by Comparison of Deaths and Population at Age (a) and Over, After Reallocaton of Excess Deaths at Age 70 and Over, Males and Females, Selected Years: Egypt

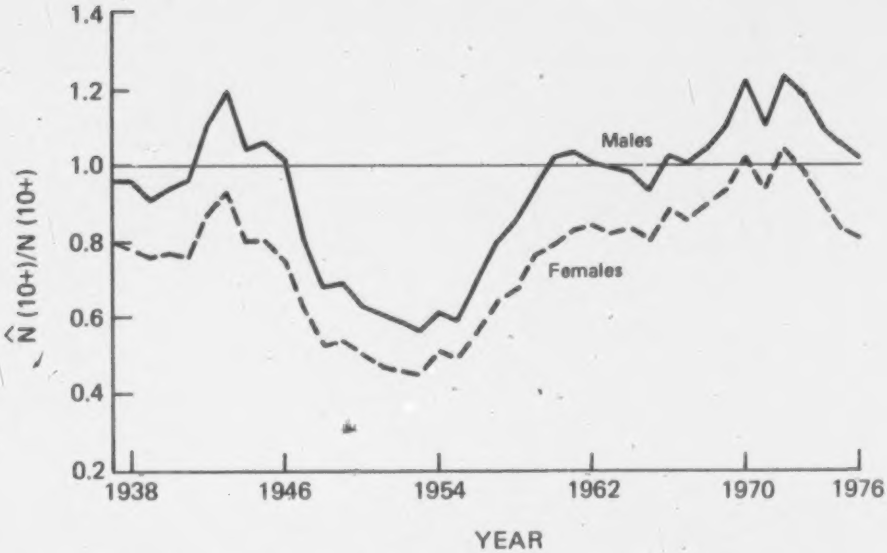


FIGURE C.7 Estimated Completeness of Death Registration at Age 10+ by Sex, 1937-76: Egypt

registration proceeds by determining the size of cohorts implied by registered deaths, on the assumption that the correct age structure and current mortality are consistent, in the sense that both could belong to the same stable population. Over a period of years this assumption is approximately valid, when fertility has been about constant, as in Egypt. However, in a particular year when an epidemic or a poor crop may raise the death rate at all ages, the mortality schedule is not consistent with the age distribution and the average rate of increase. In a year of episodic high mortality, values of $\hat{N}(a+)$ systematically exceed values of N(a+). We interpreted the high values of $\hat{N}(a+)$ in 1942 and 1943, for example, as the result of a temporary increase in the death rate. It would surely be inappropriate to assume that there was overregistration in those years, and to estimate the true number of deaths as well below the registered number. (However, the possibility of overregistration cannot be ruled out altogether; the number of registered marriages also reaches a peak in these years, and the source of some of the high rates may be delayed registration of events that occurred earlier.)

The dip to greatly reduced estimated completeness of registration in the 1950s almost certainly resulted from a genuine deterioration in the recording of deaths. The recorded death rate over age 10 fell very precipitously in the late 1940s, and then rose to former levels in the late 1950s. The low mortality rates in this period are not believable. In Figure C-8, the expectation of life at age 10, e(10), is shown as estimated three ways: first, from a "South" stable population with Egypt's population ratio ${}_{40}P_{10}/P(10+)$ and estimated growth rate; second, from a "South" stable population with Egypt's registered death rate over age 10 and estimated r; and third, from a "South" stable population with Egypt's estimated r and death rate over age 10 adjusted for underregistration. If there is no correction for underregistration, the estimates of e(10) for males and females rise to incredible levels by the early 1950s--approximating or bettering mortality in present-day Sweden--only to fall back to much lower values. On the other hand, the estimates based on the adjusted death rate follow, in a general way, the mortality implied by the age distribution and rate of population growth and are much more in accord with common sense.

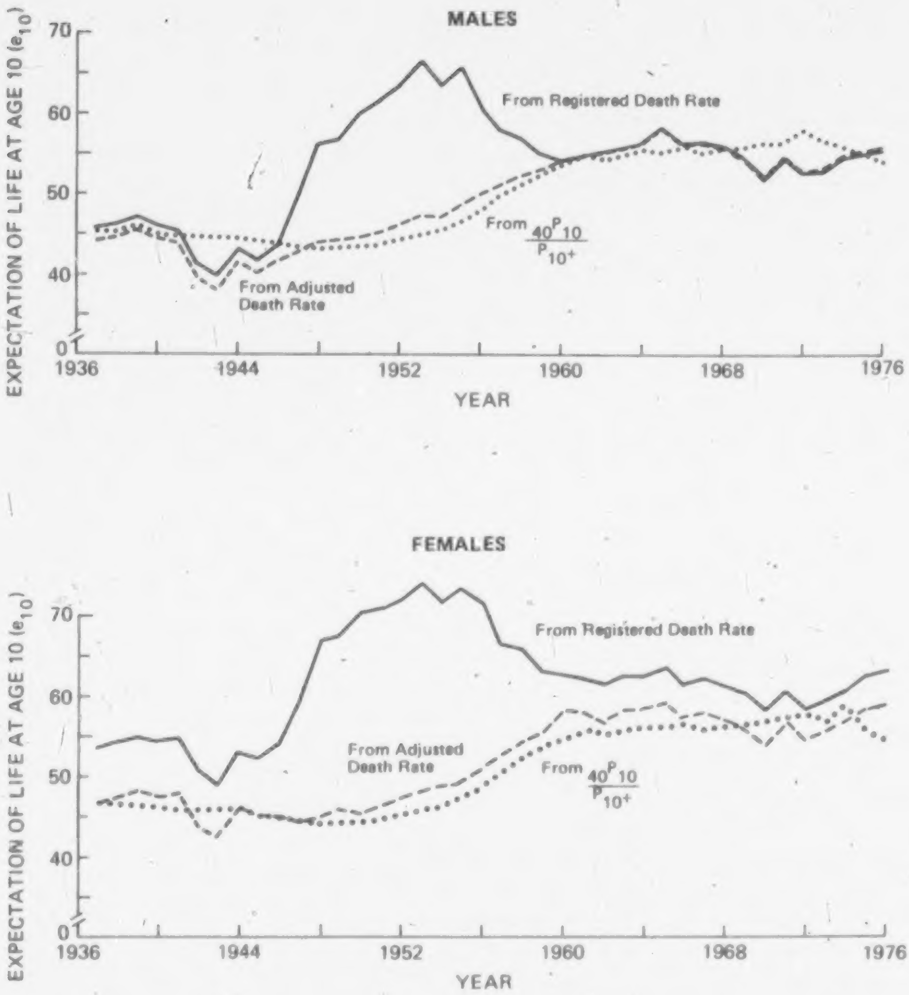


FIGURE C.8 Expectation of Life at Age 10 (e_{10}) from "South" Model Stable Populations as Implied by the Estimated Growth Rate and (1) the Ratio of the Population Aged 10 and Over, (2) the Registered Death Rate at Age 10+, and (3) the Adjusted Death Rate at Age 10+, Males and Females, 1937-76 : Egypt

Appendix D

Reconstruction of Egyptian Population Projection, 1927-77

The creation of estimates of births, infant mortality, and completeness of registration of adult mortality in Egypt from 1927 to 1976 (as summarized in Table 2 and Figure 2 in Chapter 2) provides the basis for projecting the population, by standard techniques, from 1927 to 1977. The projected population (interpolated to census dates) can be compared with the enumerated populations to determine whether estimated fertility and mortality are consistent with the increase in the population as recorded in the censuses and with the evolution of the age and sex composition of the population that the censuses indicate. The censuses cannot be taken as standards that the projected population should match, because the age distribution of the enumerated population at each census is strongly affected by age misreporting, and possibly by underenumeration that may be age- and sex-selective and may be more severe in some censuses than in others.

LIFE TABLES FOR PROJECTING THE POPULATION

The life tables used for projection are a composite, with ℓ_5/ℓ_0 and ${}_5L_0$ determined by the estimated infant mortality rate for the period in question, and ℓ_x, ${}_5L_x$, and T_x values (as needed) relative to ℓ_5 determined by the adjusted death rate over age 10 for each sex, and the rate of increase of the population aged 10 and over. In other words, for each sex, a full life table was formed by splicing survival rates over age 5, derived from corrected registered deaths over age 10, to survival rates under age 5 based on corrected infant mortality. A level of mortality was found in the "West" family of model life tables such that $_1q_0$ for the two sexes combined matched the corrected infant mortality rate for each year (Appendix A); ℓ_5 and $_5L_0$ for each sex were taken from this level. A significant feature of this procedure was the acceptance of the sex differences in mortality under age 5 in the "West" model life tables as characteristic of Egypt.

Life table values above age 5 were determined independently for each sex. Deaths over age 10 were corrected for underregistration; then a "South" model life table was chosen that would produce the corrected death rate over age 10 in a stable population growing at the rate estimated for the population over 10.

The life tables for the population projection incorporated average mortality over five-year time periods (1927-31, 1932-36, . . . , 1972-76) based on average corrected IMR for each five-year period, average corrected death rates for age 10+, and average estimated rates of increase.

Births for the Projection

The population under age 5 at the end of each quinquennial time period was calculated from the estimated number of births during the period multiplied by $_5L_0/5 \cdot \ell_0$ from the life table for the interval. The estimated number of births, as described in Appendix B, were divided into male and female births under the assumption that each year 51.46 percent of the births were male. For the period 1948 through 1959, for which no sound basis for estimating completeness of birth registration could be established, it was assumed that the annual number of births increased at a constant geometric rate from the number estimated for 1947 to the number estimated for 1960.

Initial Population and Calculation Procedures for the Projection

The projection, extending from 1927 to 1977, begins with the population enumerated in the 1927 census. Age distributions recorded in all of the Egyptian censuses are quite evidently distorted, so to accept the 1927 age distribution as reported would be to initiate the projection with numbers that are clearly too small for some age groups and clearly too large for others. Therefore, a stable population for each sex was calculated. The stable age distribution for each sex incorporated the life table constructed for 1927, and a growth rate (common to the two sexes) that yielded a birth rate of 49.3 per thousand for the two sexes combined. (A growth rate of 17.8 per thousand was required.)

The projection to 1932 and ensuing years at five-year intervals was then carried out by the conventional multiplication of the number in each five-year age interval (${}_5P_x$) by the appropriate life table survival rate (${}_5L_{x+5}/{}_5L_x$). The projected population under age 5 was filled in by calculating the number of survivors of the estimated births during each quinquennial interval.

To provide a comparison between the projected population and the population enumerated in the ensuing censuses, the projections (to February of each year in the series since the 1927 census was in February) were interpolated to the census dates.

Projection Results

Table D-1 presents the projected population by sex and five-year age intervals for 1927 to 1977. (In 1927, the "projected" population is the initial stable population described earlier.) Interpolated populations for 1960 and 1976 are also listed in the table.

The projected male population exceeds the enumerated population in 1937 by 3.6 percent, in 1947 by 1.2 percent, in 1960 by 0.8 percent, and in 1976 by 4.9 percent. (Corresponding figures for females are 1937, 4.2 percent; 1947, 1.3 percent; 1960, 2.6 percent; and 1976, 7.8 percent.) From 1927 to 1960 the average intercensal rate of increase was 18.1 per thousand; the average rate of increase of the projected population was 17.6 per thousand. The agreement between the projection and the census totals is very close in 1947 and 1960 (within about 1 percent for males). But since the 1937 census falls short of the projected population by about 4 percent only ten years after the projection starts, one may suppose that the 1937 census was an undercount. The 1976 census is some 6 percent below the projected figure. However, the official estimate of Egyptians residing abroad in 1976 is 1.425 million. The projection cannot

TABLE D-1 Projected Population by Sex and Five-Year Age Groups at Five-Year Intervals and the 1960 and 1976 Census Dates, 1927 to 1977: Egypt

	1927		1932	
Age Group	Males	Females	Males	Females
0-4	1,150,677	449,134	1,260,896	1,247,568
5-9	912,680	912,116	996,608	996,200
10-14	805,114	801,973	876,950	872,547
15-19	715,124	709,558	779,466	773,142
20-24	625,910	621,273	680,921	676,273
25-29	542,413	540,463	589,802	587,584
30-34	469,926	468,126	511,016	509,365
35-39	405,769	404,831	441,270	439,814
40-44	347,328	348,799	377,376	379,197
45-49	293,192	299,387	318,487	325,518
50-54	242,657	253,678	263,258	275,595
55-59	194,591	208,966	210,533	226,814
60-64	147,655	163,328	159,126	176,209
65-69	102,130	116,266	109,688	124,576
70-74	61,264	71,554	65,172	75,841
75-79	29,362	34,745	30,669	36,469
80+	12,563	15,308	12,911	15,686
All Ages	7,058,073	7,119,791	7,684,143	7,738,388

	1937		1942	
Age Group	Males	Females	Males	Females
0-4	1,318,500	1,300,933	1,403,607	1,383,420
5-9	1,097,115	1,085,259	1,156,545	1,146,740
10-14	951,954	945,798	1,056,866	1,047,108
15-19	845,248	836,224	923,407	917,878
20-24	737,200	731,292	807,168	803,881
25-29	636,382	634,038	697,147	698,479
30-34	551,225	548,697	601,602	603,791
35-39	476,012	474,002	519,412	521,075
40-44	406,747	408,036	444,409	448,810
45-49	342,589	350,545	374,596	384,888
50-54	282,683	296,448	309,142	326,610
55-59	225,200	242,937	246,763	269,292
60-64	168,860	187,162	185,688	209,865
65-69	114,912	129,842	126,963	148,271
70-74	67,153	77,086	74,627	89,652
75-79	30,695	35,657	34,489	42,756
80+	12,689	15,138	13,677	17,267
All Ages	8,265,157	8,299,089	8,976,098	9,059,772

TABLE D-1 (continued)

Age Group	1947 Males	1947 Females	1952 Males	1952 Females
0-4	1,449,348	1,429,896	1,856,537	1,817,193
5-9	1,216,152	1,208,818	1,296,879	1,280,414
10-14	1,098,368	1,096,053	1,169,811	1,158,721
15-19	1,014,319	1,008,785	1,064,252	1,058,298
20-24	867,670	874,076	967,017	963,414
25-29	748,365	759,530	818,861	828,593
30-34	646,500	657,597	706,078	717,583
35-39	556,056	566,645	607,980	619,377
40-44	474,639	487,543	517,992	532,118
45-49	399,513	418,406	436,035	456,150
50-54	328,787	353,860	359,491	386,245
55-59	260,823	291,540	286,011	317,574
60-64	194,204	226,517	214,043	247,243
65-69	130,404	159,428	145,014	174,321
70-74	74,584	96,125	83,840	105,403
75-79	33,019	45,265	37,748	49,992
80+	13,224	18,636	14,383	20,409
All Ages	9,505,967	9,698,716	10,581,964	10,733,040

Age Group	1957 Males	1957 Females	1960 Males	1960 Females
0-4	2,067,944	2,021,706	2,286,583	2,229,116
5-9	1,678,134	1,644,301	1,841,400	1,804,533
10-14	1,259,821	1,240,236	1,540,216	1,510,900
15-19	1,141,877	1,127,859	1,213,666	1,196,083
20-24	1,025,949	1,021,262	1,091,216	1,081,916
25-29	925,056	924,222	978,033	977,033
30-34	782,808	792,701	866,850	870,400
35-39	672,819	684,730	734,633	747,350
40-44	574,709	589,260	627,316	642,750
45-49	483,742	504,312	529,866	550,583
50-54	399,834	427,285	438,700	467,133
55-59	320,028	353,361	352,966	388,116
60-64	242,202	277,284	270,666	309,250
65-69	167,245	199,158	190,649	226,950
70-74	99,533	123,355	117,058	145,933
75-79	46,608	60,594	57,278	75,220
80+	17,749	24,834	22,644	32,253
All Ages	11,906,051	12,016,456	13,159,740	13,255,519

TABLE D-1 (continued)

	1962		1967	
Age Group	Males	Females	Males	Females
0-4	2,373,279	2,311,422	2,625,139	2,549,909
5-9	1,906,309	1,868,270	2,214,496	2,160,171
10-14	1,651,260	1,618,485	1,886,597	1,846,967
15-19	1,241,674	1,222,604	1,634,938	1,601,251
20-24	1,117,063	1,106,307	1,223,249	1,204,851
25-29	999,041	998,097	1,097,024	1,087,010
30-34	899,588	901,484	979,621	978,993
35-39	758,777	771,612	879,425	882,549
40-44	648,051	664,461	737,791	753,102
45-49	547,995	569,369	624,499	645,723
50-54	454,149	482,766	520,693	548,570
55-59	366,202	402,093	422,051	458,114
60-64	281,560	321,889	328,571	370,877
65-69	199,818	238,345	238,846	381,981
70-74	123,936	154,880	153,987	190,516
75-79	61,519	81,041	80,818	105,727
80+	24,641	35,166	35,305	50,225
All Ages	13,654,856	13,748,285	15,683,044	15,716,532

	1972		1976	
Age Group	Males	Females	Males	Females
0-4	2,600,271	2,522,956	2,873,304	2,774,374
5-9	2,452,246	2,384,062	2,448,377	2,379,134
10-14	2,185,158	2,128,791	2,408,488	2,341,524
15-19	1,863,580	1,822,516	2,148,590	2,093,215
20-24	1,604,894	1,572,658	1,820,625	1,784,047
25-29	1,196,092	1,179,242	1,561,659	1,534,317
30-34	1,071,134	1,061,849	1,162,188	1,148,331
35-39	953,487	954,401	1,037,483	1,031,961
40-44	850,942	857,728	918,050	924,691
45-49	707,099	728,765	811,445	827,452
50-54	589,693	619,152	664,257	696,723
55-59	480,240	517,330	540,992	582,393
60-64	374,827	418,636	424,086	471,898
65-69	274,718	320,322	311,422	361,380
70-74	180,352	220,804	205,962	251,116
75-79	97,661	126,362	113,244	146,940
80+	45,912	64,931	56,240	80,107
All Ages	17,528,240	17,500,480	19,506,612	19,429,603

TABLE D-1 (continued)

	1977	
Age Group	Males	Females
0-4	2,885,567	2,785,952
5-9	2,458,826	2,389,062
10-14	2,418,767	2,351,295
15-19	2,157,760	2,101,950
20-24	1,828,395	1,791,492
25-29	1,568,324	1,540,720
30-34	1,167,148	1,153,123
35-39	1,041,911	1,036,267
40-44	921,968	928,550
45-49	814,908	830,905
50-54	667,092	699,630
55-59	543,301	584,823
60-64	425,896	473,867
65-69	312,751	362,888
70-74	206,841	252,164
75-79	113,928	147,553
80+	56,480	80,441
All Ages	19,589,808	19,510,624

Note: The projection dates are February for each year except the census years 1960 (September) and 1976 (November).

but include these nonresidents. Adding 1.425 million to the resident population leads to an aggregate difference of less than 3 percent between projected and enumerated population, after nearly 40 years of projection. The average annual projected rate of increase for 1927 to 1976 exceeds the average rate of increase of the enumerated population between those years by less than 1 per thousand. Adjusted birth and death rates may be in error, but the differences between them, at least, are very consistent with the recorded growth of the Egyptian population.

In Figures D-1 and D-2, the enumerated population at each age, male and female, is compared with the projected population in the five censuses from 1927 to 1976. (The "projected" population for 1927 is the fitted stable population.) For both sexes, but especially males, a consistent tendency toward undercounting and overcounting in the same age intervals is evident in every census from 1927 to 1976, with a general trend toward reduced

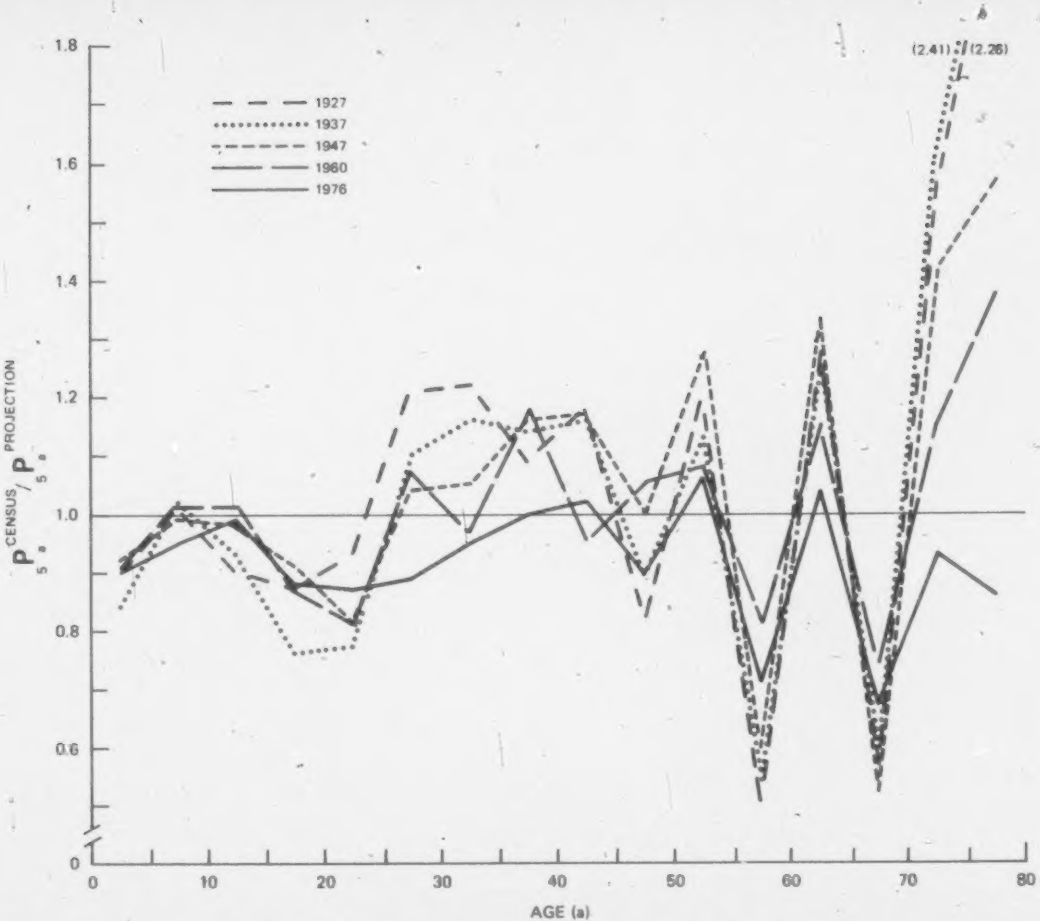


FIGURE D.2 Ratio of the Enumerated Population to the Projected Population by Five-Year Age Groups, Females, 1927, 1937, 1947, 1960, and 1976: Egypt

distortion in the reported age distribution. Note in particular that the alternate ups and downs after age 50 are much smaller in 1976 than in the earliest censuses, and that the very strong overstatement of the male population over age 75 goes from 2.2 in 1927, to 2.1 in 1937, to 1.6 in 1947, to 1.5 in 1960, to no overstatement in 1976.

A notable feature of the 1976 census in comparison with the other four censuses is the lower ratio of enumerated to projected population between ages 25 and 45 or 50. This deficit of enumerated young adults relative to the projection, at ages at which the other censuses generally showed a greater enumerated than projected population, is probably the effect of the concentration at these ages of the population living abroad.

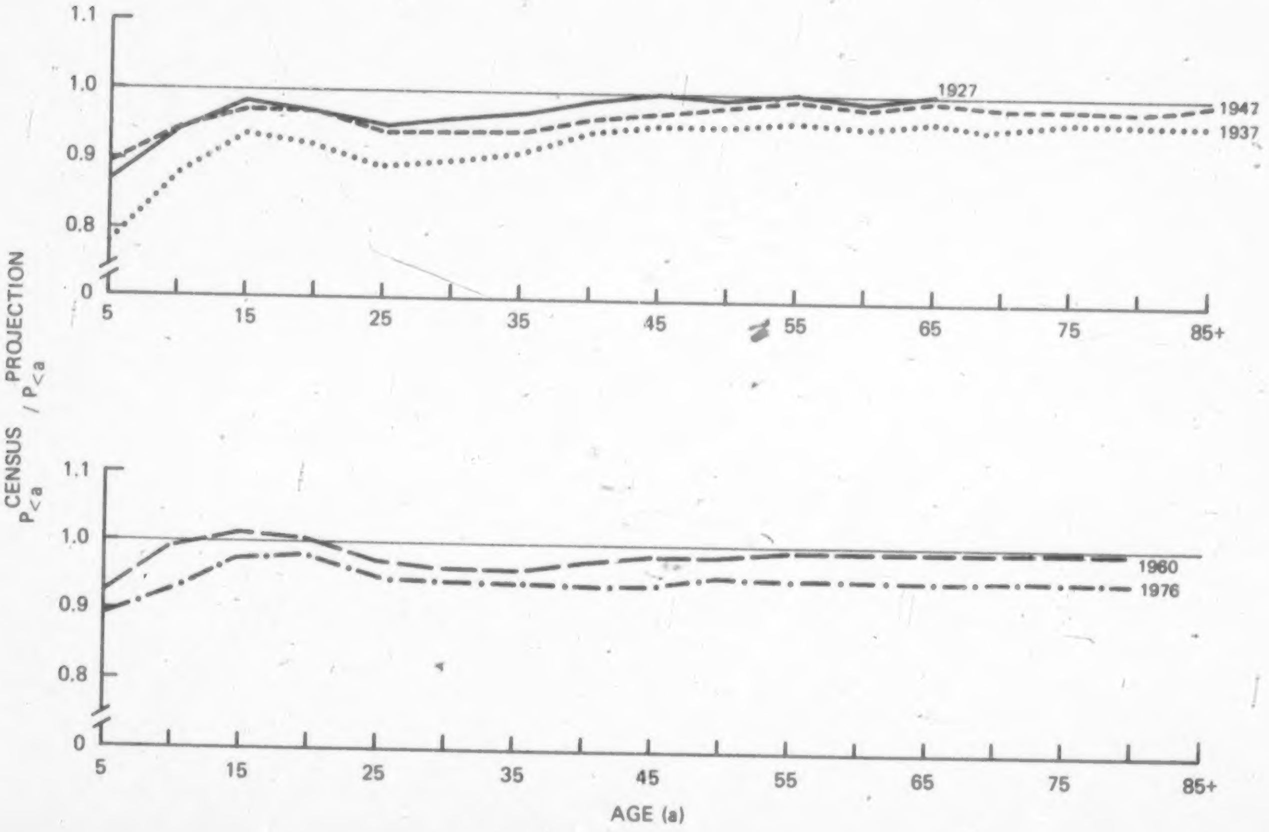
For females the ratios of enumerated to projected population show a puzzling irregularity in the 1960 census, with dips at 30-34 and 40-44, and peaks at 35-39 and 45-49, contrary to the other censuses. The irregularity occurs in the enumeration of females, not in the projection. In Figure D-3, in which the ratio males/females is shown by age for the five censuses, there is a structural similarity in the irregular patterns from one census to the next, with 1960 out of synchronization, one might say, with the others, from age 20 to age 50.

The comparison of the cumulated male and female enumerated populations with the cumulated projected populations in consecutive censuses (Figure D-4) shows the overall agreement in size and structure of the projected and observed populations. The pattern of the ratio of the recorded to the projected population is especially similar in the first three censuses, except that the 1937 ratio of census to projected is at all ages a few percent below the others. This suggests that the projected age structure is not far from the true structure, that the three censuses had very similar patterns of age misreporting and differential omission by age, and that the 1937 census was undercounted by some 3 or 4 percent more than the other two.

IMPLICATIONS OF THE RESULTS

What do the projections imply about the accuracy of our adjusted figures? We have already noted the small difference (0.74 per thousand) in the average rate of

MALES


1.1
1.0
0.9
0.8
0
5
15
25
35
45
55
65
75
85+
1927
1947
1937
$P_{<a}^{CENSUS} / P_{<a}^{PROJECTION}$
1.1
1.0
0.9
0.8
0
5
15
25
35
45
55
65
75
85+
1960
1976
AGE (a)

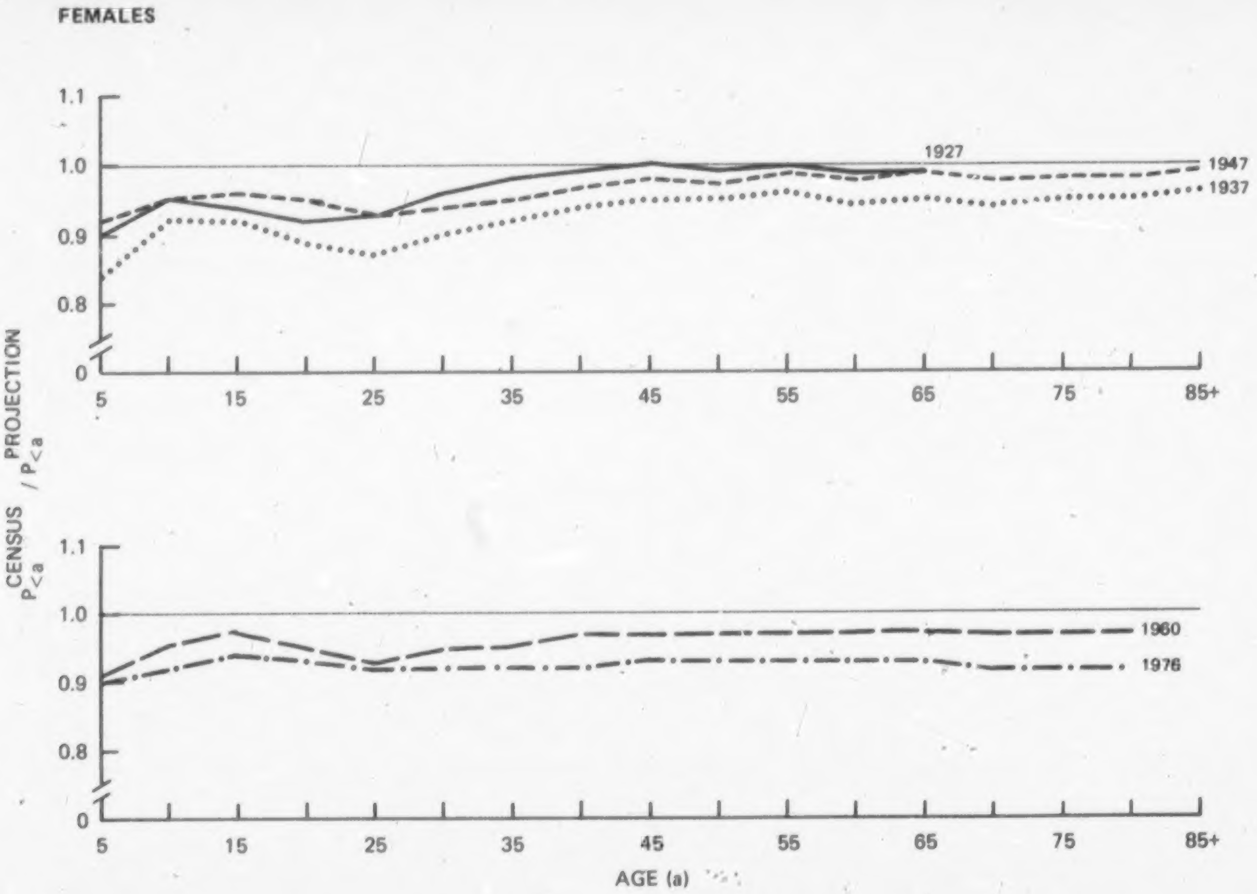


FIGURE D.4 Ratio of Cumulated Enumerated Population to Cumulated Projected Population, Males and Females, 1927, 1937, 1947, 1960, and 1976: Egypt

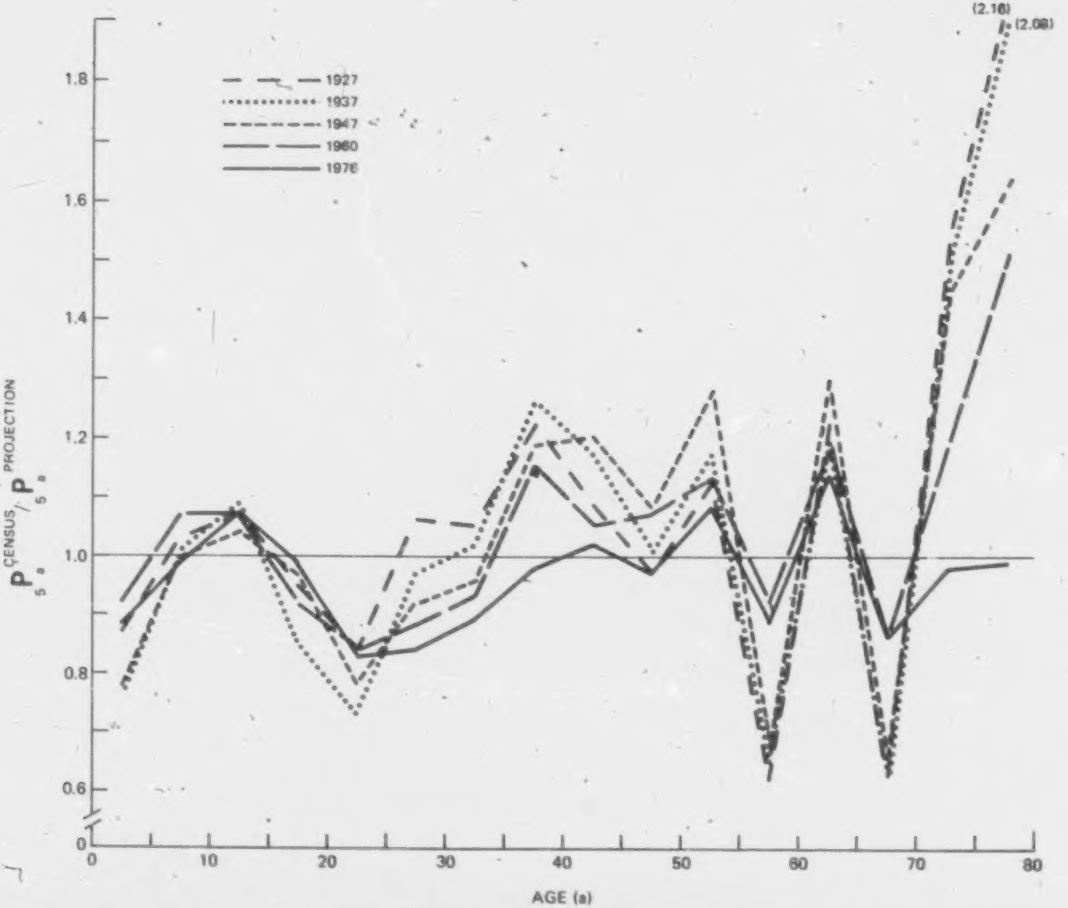


FIGURE D.1 Ratio of the Enumerated Population to the Projected Population by Five-Year Age Groups, Males, 1927, 1937, 1947, 1960, and 1976: Egypt

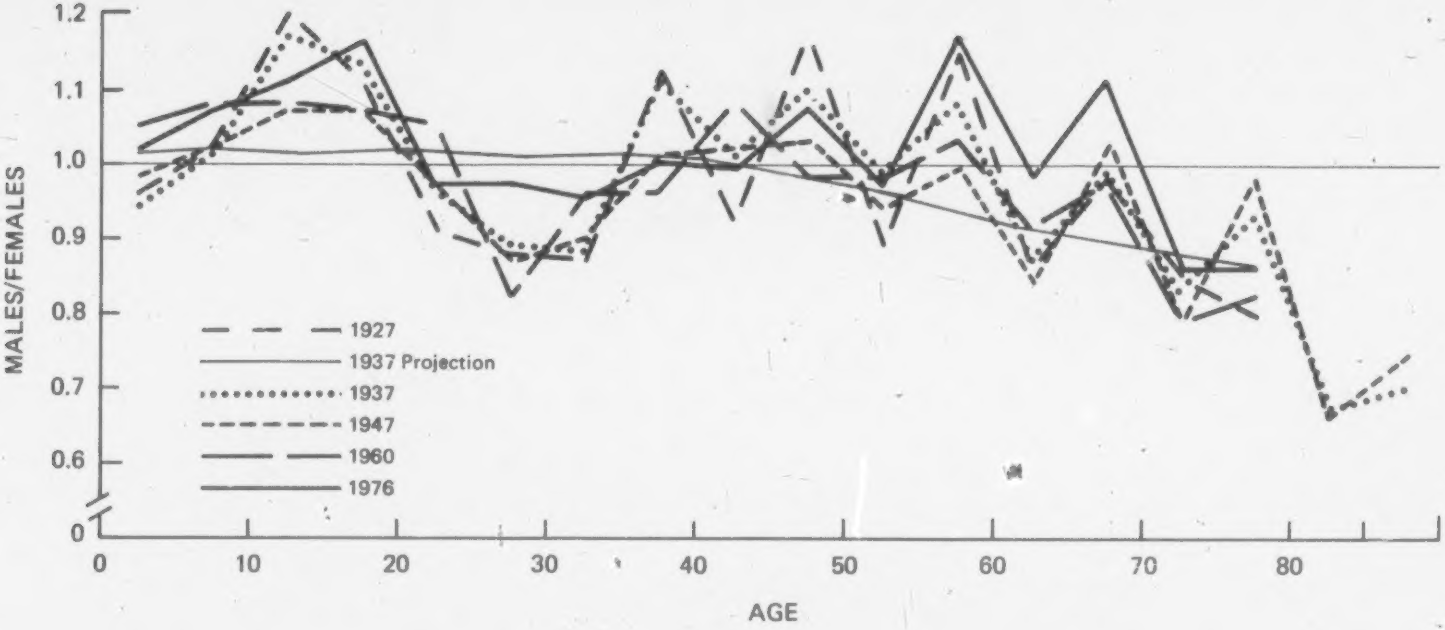


FIGURE D.3 Ratio of Males to Females by Age as Enumerated in the Censuses, 1927, 1937, 1947, 1960, and 1976, and in the Projected Population, 1937: Egypt

increase for 1927-76 between the enumerated and projected populations. This consistency in growth of numbers implies that the average difference between adjusted birth and death rates is about correct--but both might be too high or too low. The projected population is a little larger than the enumerated; if an error is implied in the estimated natural increase, it is that the estimated natural increase is slightly higher than the true value.

The most uncomfortable feature of our estimation is the selection of age-based values of estimated IMR from the 1947 census to compare with average infant mortality in 1946-47 in each governorate. This choice of rates for comparison combined the higher of the child survival estimates of IMR (age-based rather than duration-based) with a low set of registered IMRs--to avoid the imputation of substantial overregistration of IMR in a number of governorates. The result is a rather large adjustment of the IMR recorded in all Health Bureaus, a large adjustment that carries over to other years, leading to high levels of estimated IMR in the 1930s through the 1950s. These high rates, combined with corrected numbers of deaths at higher ages yield expectations of life at birth in the 1930s of only about 30 years.

If the infant mortality correction is too large, and the estimated infant mortality rates are too high, the projected population should fall short of the enumerated population--unless the estimates of the birth rate are also too high. The birth rate estimates, however, are taken from the Health Bureau areas (from 1927 to 1947) without adjustment. There is no apparent reason why these rates should be systematically too high.

The agreement of both the proportionate distribution and the aggregate size of the projected populations with the census populations, supports the approximate correctness of the estimated mortality and fertility rates. Cumulated percent distributions by age (projected and enumerated) are shown in Figure D-5. The census distribution is consistently lower at age 5, because of the usual tendency to undercount young children. The overall cumulative age structures are quite congruent, implying that the estimates of mortality and fertility are consistent with the structure as well as the growth of the Egyptian population.

There are, however, inconsistencies between the projected population and the population enumerated in the censuses that should be noted. An examination of the sequence of ratios (enumerated/projected) for the same age from census to census shows that the ratios in successive censuses for two cohorts (those 5-9 and 10-14 in 1927) are generally low (Figure D-6). These low ratios (at 15-19 and 20-24 in 1937, 25-29 and 30-34 in 1947, 40-44 and 45-49 in 1960, and 55-59 and 60-64 in 1976) imply that the stable population fitted in 1927 overstated the number at ages 5-9 and 10-14, and thus generated projected numbers too large for these cohorts in later censuses. Since the cohorts in question were born in 1912-16 and 1917-22, World War I and the influenza epidemic of 1918-19 may well have diminished their numbers.

Another inconsistency is the larger difference for females than for males between enumerated and projected populations, in later censuses and at older ages. These larger differences can be seen in a male-female comparison of the right-hand parts of Figure D-6. For example, note the age groups 55-59 and 65-69; the female differences are about twice as large as the male differences. Either there is a growing relative undercount of women, or our estimate of female mortality--although it includes a consistently higher estimate of the proportion of deaths omitted than for male mortality--should be slightly higher.

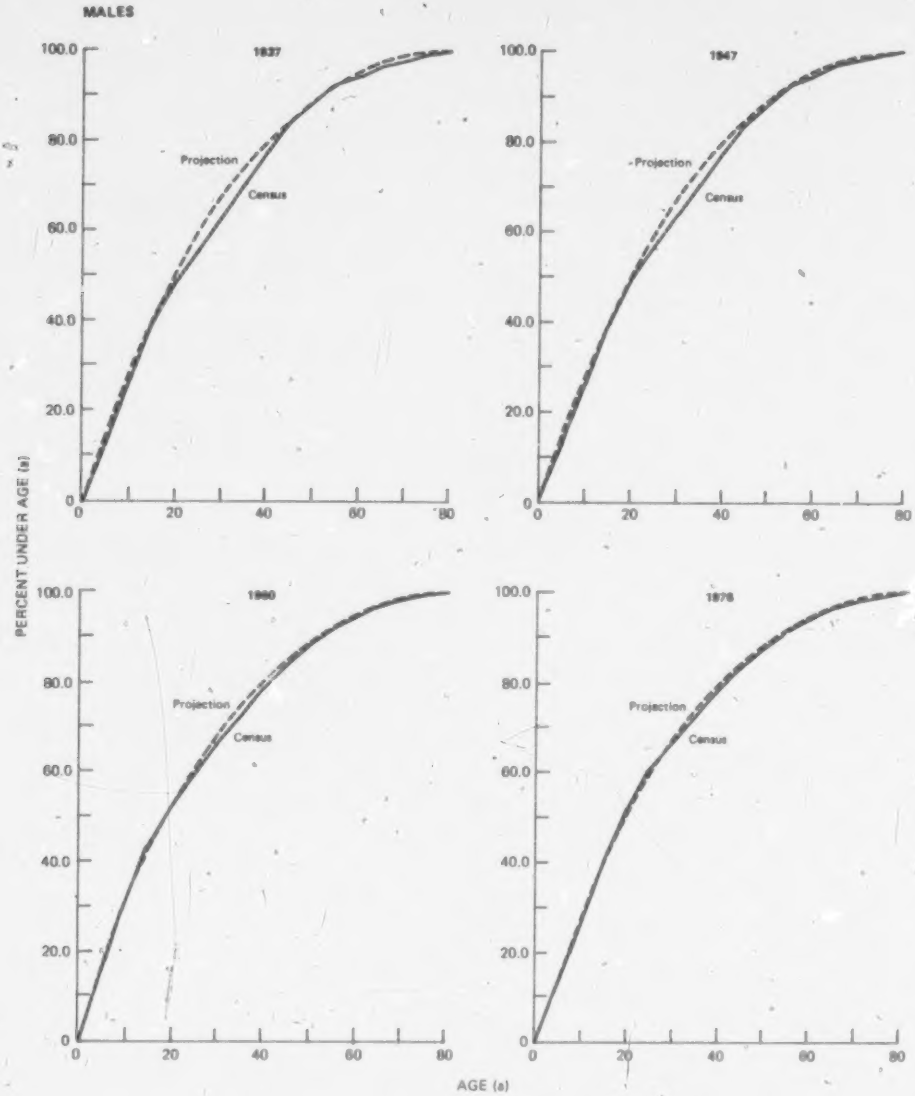


FIGURE D.5 Cumulated Percent Distribution by Age of the Enumerated and the Projected Population, Males and Females, 1937, 1947, 1960, and 1976: Egypt

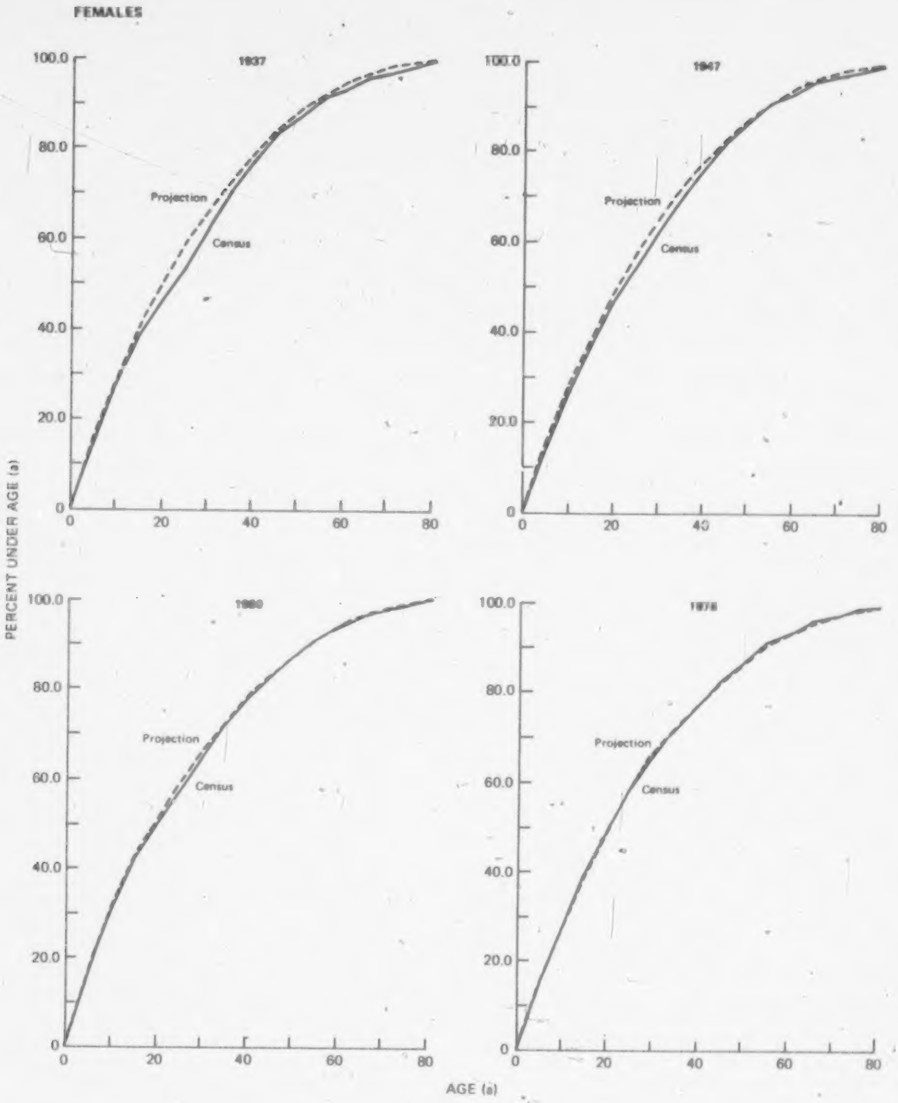


FIGURE D-5 (continued)

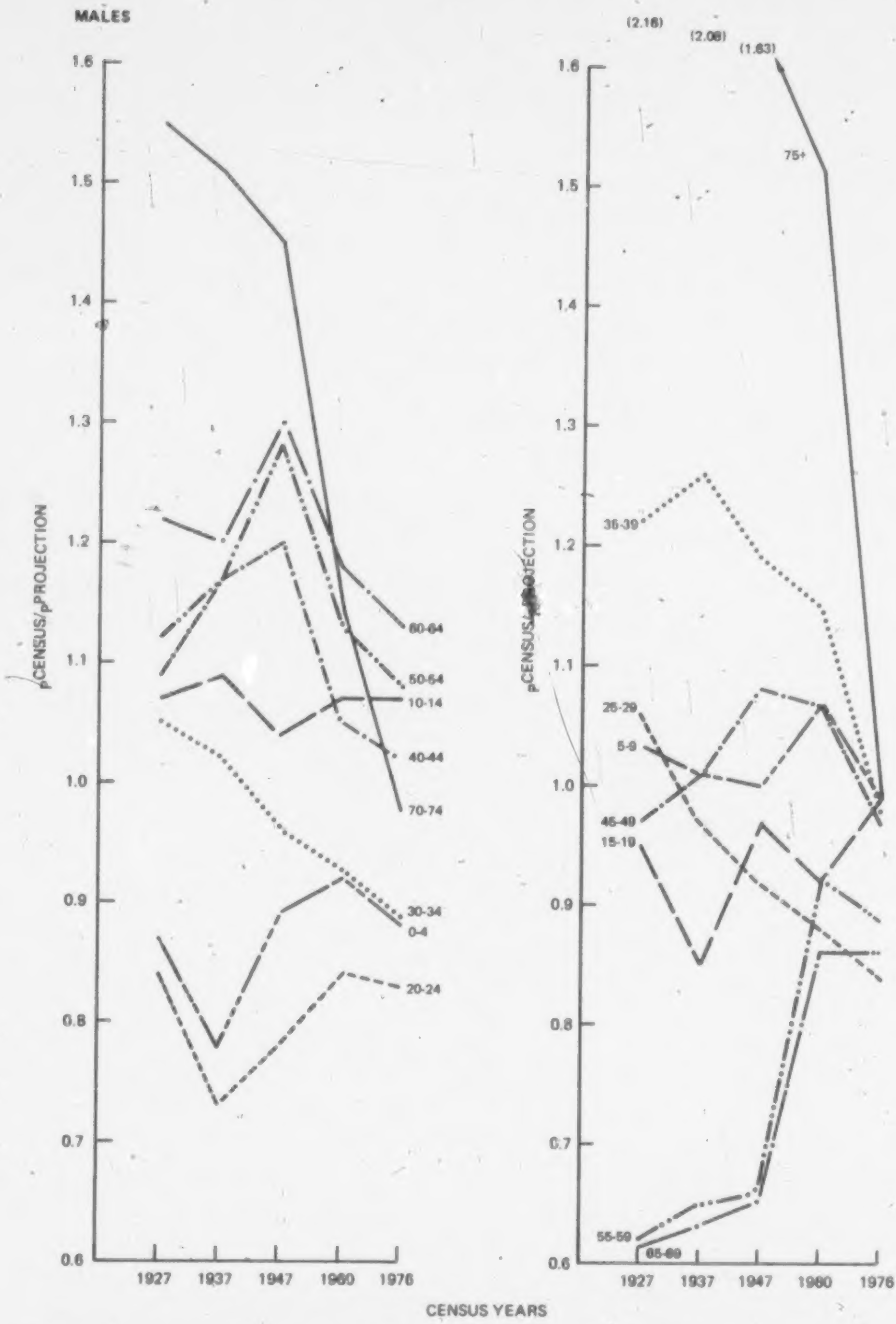


FIGURE D.6 Ratio of the Enumerated Population to the Projected Population by Age Groups, Males and Females, 1927, 1937, 1947, 1960, and 1976: Egypt

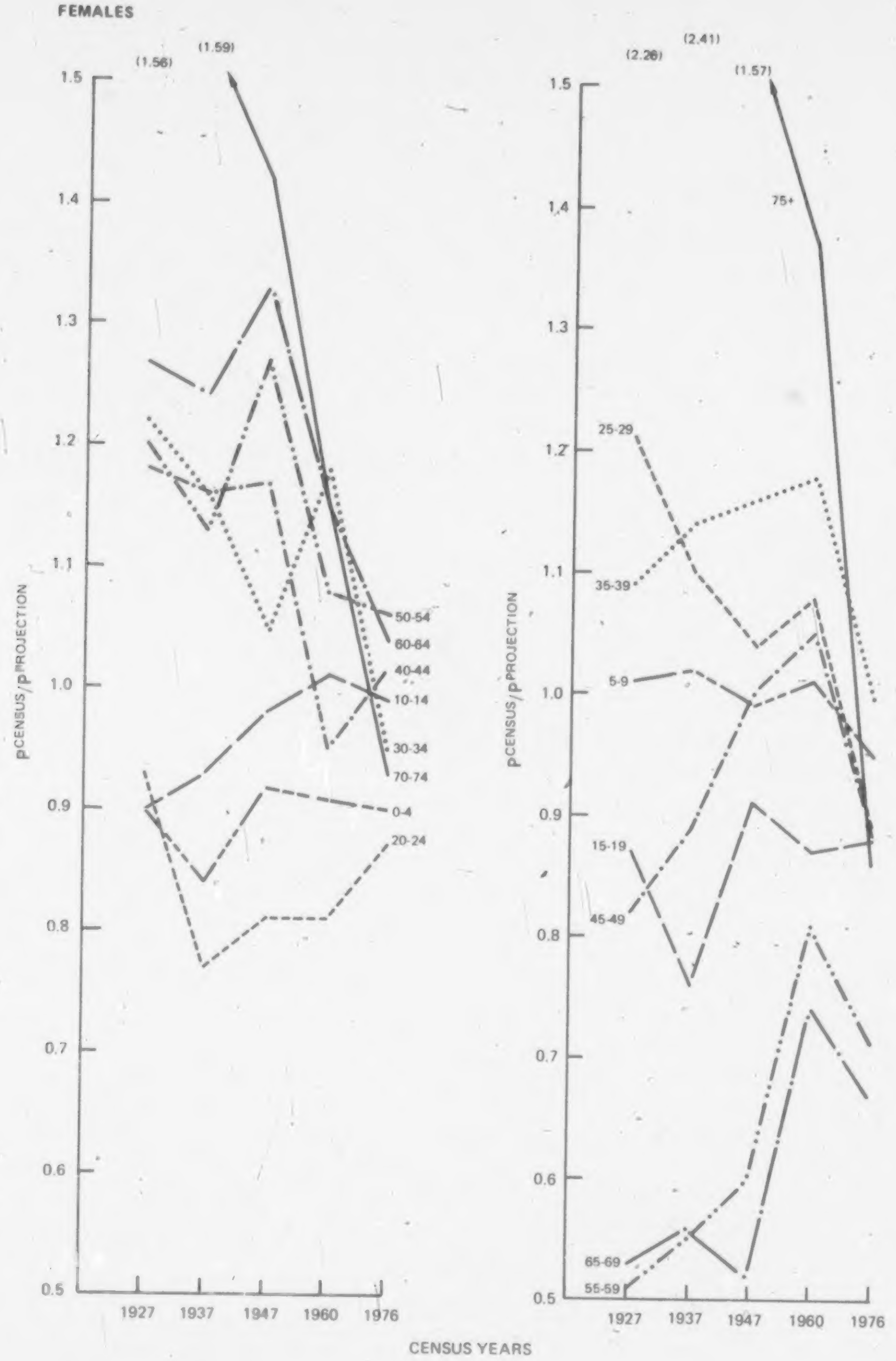


FIGURE D-6 (continued)

Appendix E
Underregistration of Marriages, 1948-60

In Appendix B it was noted that when the number of registered births in the 1950s is projected to the appropriate ages in 1960 and 1976, the calculated population falls short of the enumerated population by a larger margin than do projected populations of appropriate ages in 1937, 1947, 1960, and 1976 when based on registered births in the 1930s, 1940s, 1960s, and 1970s. In addition there were absurdly small numbers of births recorded in some districts in governorates in which the birth rate was especially low in 1956 or 1957 (or both).

In Appendix C, annual estimates of completeness of registration of deaths over age 10 revealed a decline in completeness for male deaths from nearly 100 percent up to 1947 to about 60 percent in the 1950s, and from 80 to 50 percent for female deaths, with a subsequent recovery.

In this appendix, we show that the recording of marriages also deteriorated in the 1950s. The absolute number of recorded first marriages was above 182,000 in every year but one (1947) from 1942 through 1950 and was below 182,000 in every year but one (1960) from 1951 through 1962. The ratio of the number of first marriages to a crude estimate of the number of women at the mean age of first marriage is shown in Figure E-1. (The mean age at first marriage was a little less than 20 years during this period; the divisor used in the ratio is the interpolated number of females at ages 10 to 29, divided by 20.) Since very few Egyptian women remain single, this "first marriage rate" would be expected to have an average value near 1.0, unless the mean age at first marriage changed. (A rise in mean age at marriage of one year reduces the expected number of marriages over a period of a few years by the number that would normally

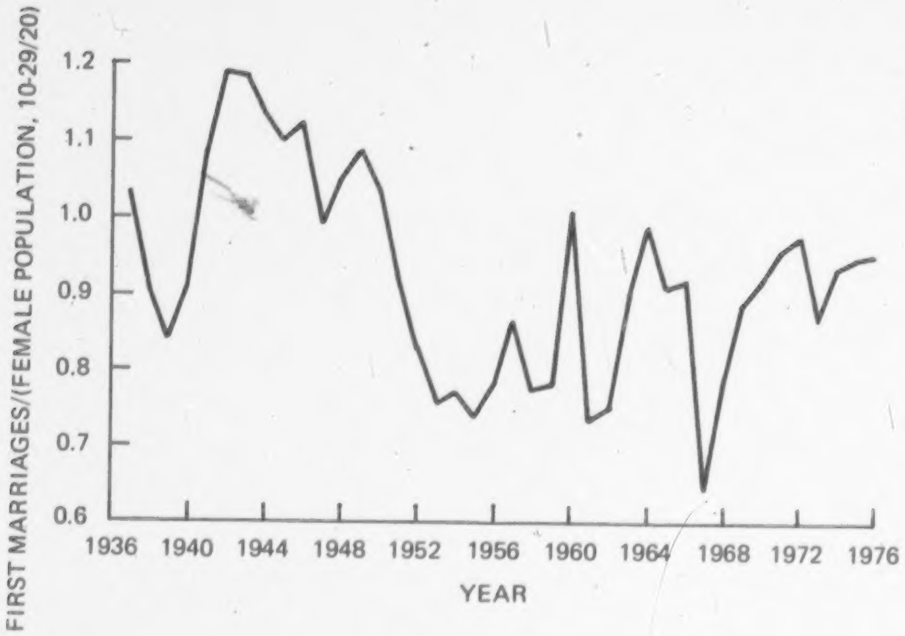


FIGURE E.1 "First Marriage Rate" Measured as the Ratio of Registered First Marriages to One-Twentieth the Female Population Aged 10 to 29, 1937-76: Egypt

occur in one calendar year.) The rate does indeed oscillate about 1.0 from 1947 to 1950 but then falls to very much lower values during the 1950s. Clearly, the low absolute number of reported first marriages after 1950 was not the result of a reduced number of women of eligible age.

If the number of first marriages and the first marriage rate had truly fallen as the reported figures indicate, it could be inferred that the mean age at marriage rose, and that more young women remained single. In fact, it appears that the fraction of registered first marriages in which the bride was less than 20 years old was higher in the 1950s than in the 1940s (see Figure E-2). Moreover, the proportion ever married at young ages in the 1960 census was virtually the same as in the 1947 census. The number of first marriages recorded in the 10 years before the 1947 census (1.632 million) was 107.1 percent of the number of ever married women less than 30 years old reported in the

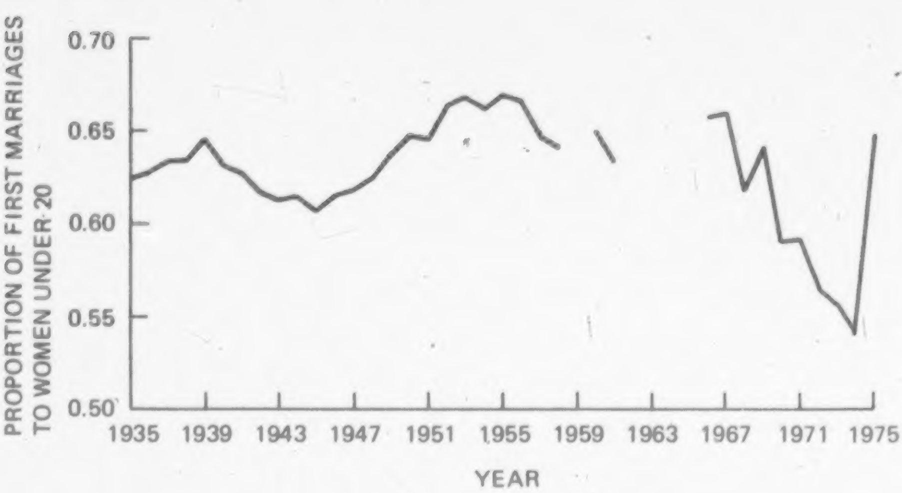


FIGURE E.2 Proportion of Registered First Marriages Occurring to Women Under the Age of 20, 1935-75: Egypt

census. In 1960 the 1.706 million first marriages recorded in the 10 preceding years was 79.2 percent of the reported number of ever married women less than 30; in 1976 the 2.750 million first marriages in the 10 preceding years was 96.1 percent of the recorded number of ever married women less than 30. The decline in the ratio of first marriages to ever married women from 1.07 to .96 from 1947 to 1976 is in small part the result of declining mortality (more of the first married died before the census in the 1940s), but the decline of the ratio to .792 in 1960 suggests the omission of many marriages in the registered figures. This finding is consistent with the evidence of underregistration of births and deaths during the 1950s.

Appendix F

An Analyis of Underregistration of Births and Deaths in Egypt Based on a CAPMAS Survey, 1974-75

Underregistration of vital events is common in most developing countries. As described elsewhere in this report, Egyptian vital statistics suffer from varying degrees of underregistration of births and deaths. Underregistration occurs particularly in rural areas and especially in rural areas that do not have Health Bureaus, where births and deaths are normally registered. The Central Agency for Public Mobilisation and Statistics (CAPMAS) therefore undertook a survey aimed at continuously observing vital events in a representative sample, recording such events, and checking whether they were reported to the Health Bureaus.

The survey covered the two calendar years 1974 and 1975. A sample of about 2.5 percent of small administrative units (the village in rural areas and the district in urban areas) was selected. The sample included 43 urban districts (Shiyakhas) and 105 villages, representing the following strata: Urban areas: Cairo and Alexandria, urban centers in Lower Egypt (excluding the Canal Zone, not covered by the survey), and urban centers in Upper Egypt; Rural areas: rural Lower Egypt and rural Upper Egypt. Once a district or village was selected, all households therein were covered, except in large urban districts where, in order to reduce the number of households to be covered, an area including about 1,000 households was selected from within each sample district. The size of the sample population in each stratum is shown in Table F-1. The sample was designed to provide reliable estimates of the completeness of birth and death registration, and estimates of fertility and mortality, for five major geographic and urban-rural divisions of Egypt.

About half the sample units were surveyed in 1974 and half in 1975. The data collection consisted of (1) a "census" of all households and individuals, on a basis that included both de facto and de jure elements; (2) four visits to each household, at three-month intervals, in which all changes were recorded, including births, deaths, pregnancies by duration, and other additions to the household and departures from the household; (3) preparation of lists of births, deaths, and stillbirths from the records of the Health Bureau to which each sample district or village belongs. At the end of the year, the lists prepared from the Health Bureau records were compared with corresponding lists prepared from the results of the household visits.

Matching procedures included the following features:

(a) Unmatched cases were checked in both sources, first with the concerned Health Bureau staff and second with the household itself.

(b) Although the analyses were done on a de jure basis, events that occurred to any sample-area household member outside the sample area were considered matched if the household had any official document that proved the registration.

(c) Since a birth may have an appellation name plus an official name registered in the civil registration records, such cases were considered matched after assuring that the birth referred to the same person.

(d) Events that occurred to persons in the sample areas were considered matched if it was found that the event was registered in any Health Bureau, even if that Bureau was not located within the Health Bureau area of the interviewed household.

(e) Some births registered in the civil registration records were found later to refer to births that occurred in years preceding the survey year, i.e., these births were recorded with erroneous birth dates. Events in this category were disregarded in the matching process, in order to avoid false non-matches.

In a survey of this nature, many details of the survey operation and the matching can affect the results, and adjustments may be necessary. Two significant adjustments were made in the survey data. One adjustment was aimed at correcting an error arising from the difference between

TABLE F-1 Underregistration of Births by Region, 1974-75: Egypt

Region	Total Sample Population	Number of Births: Recorded in Survey and in Registration System	Recorded in Registration System Only	Recorded in Survey Only	Total	Estimated Under-registration (percent)
Cairo and Alexandria	54,314	1,156	19	28	1,203	2.33
Urban Lower Egypt	87,492	2,623	66	150	2,839	5.28
Urban Upper Egypt	66,740	2,373	54	250	2,677	9.34
Rural Lower Egypt	265,380	8,176	745	1,098	10,019	10.96
Rural Upper Egypt	221,200	6,858	840	2,490	10,188	24.44
All Egypt (weighted)[a]						12.36

[a] The weights are the total births in 1974-75 as given in the vital statistics of the registration system.

de facto and de jure registration of births. Although in Egypt it is a legal requirement to register a birth in the locality of occurrence (de facto), births are frequently reported in the locality of residence (de jure) when the latter differs from locality of birth. Such erroneous reporting was substantial in Cairo and Alexandria where 24 percent of the sample births took place outside the locality of residence, compared to only 1 to 3 percent in all other regions, urban and rural. Treating such births as non-matches would have introduced a substantial matching error in the data for these two cities. Hence in the follow-up inquiry among unmatched cases, each family was asked whether a reported birth was registered and whether a birth certificate or a ration card showing date of birth could be shown to the interviewer. This information was used to allocate births that took place outside the locality of residence according to whether or not they were registered, i.e., procedure (b) above was applied.

The second adjustment was necessary to correct a bias due to the existence of delayed registration beyond the cut-off date adopted for matching purposes. The matching of births reported during the household visits, against births appearing in registration records was continued only through the end of February of the year following the year of birth (that is, the 1974 births were followed up in the registration records through February 1975 and the 1975 births through February 1976). Thus any 1974 or 1975 births which were registered after February of the next year were erroneously counted as not registered (unmatched). To adjust for this error, a distribution of births by interval between birth and registration was calculated for each region, to provide an estimate of the births expected to be registered after February of the next year. For instance, the number of December births was multiplied by a correction factor equal to the proportion of total births registered more than two months after birth. Similarly for November births the correction factor was based on the proportion registered more than 3 months after birth, and so on. The correction factors derived this way are acceptable if no seasonal pattern of registration delay exists. Fortunately, no such pattern was evident for any region.

In rural Upper Egypt the resulting correction factors were 14 percent for December births, 9 percent for those of November, and declining amounts for October, etc. down to .5 percent for May births. The percentages were somewhat smaller in rural Lower Egypt and much smaller in urban areas. In Cairo and Alexandria and in urban Lower Egypt the correction factors were 2 percent and 1 percent for December and November births respectively.

SUMMARY OF RESULTS

Tables F-1, F-2, and F-3 present, respectively, the number of births, deaths, and infant deaths recorded in both sources (household interview and registration system), and in one source only, either interview or registration. The estimated number of events missed in both sources, calculated by the Chandrasekar-Deming formula (see Glossary), was not included because of doubts regarding independence between the two sources, at least in some regions.

As expected, underregistration of births in urban areas, except in Upper Egypt, is quite limited: a little over 2 percent in Cairo and Alexandria and 5 percent in urban Lower Egypt. The percentage is higher in urban Upper Egypt, about 9 percent. Even in rural Lower Egypt underregistration is moderate, approximately 11 percent. It is only in rural Upper Egypt that underregistration of births is quite serious: one out of four births is not registered, according to this survey. These regional results weighted by total births 1974-75 given in civil registration data, lead to an estimate of underregistration for the whole country of a little over 12 percent for the 2-year period 1974-75.

The picture is similar--and surprisingly of the same magnitude--in the case of mortality (see Table F-2). In Cairo and Alexandria underregistration of deaths is only a little over one percent. In other regions, underregistration of deaths is close to the level of underregistration of births: 6 percent in urban Lower Egypt, 11 percent in urban Upper Egypt, 9 percent in rural Lower Egypt, and 28 percent in rural Upper Egypt, giving a weighted average of 13 percent for the whole country.

The serious effect of underregistration of infant deaths on overall underregistration is demonstrated by comparing Tables F-2 and F-3: between 56 and 77 percent of the non-registered deaths in the sample were infants, without a regional pattern, e.g., in urban Lower Egypt there were 35 infant deaths among a total of 62 deaths in the category "recorded in survey only," or 56 percent. For infant deaths, underregistration ranges from 4 percent in the two large cities to 55 percent in rural Upper Egypt (see Table F-3).

The tendency not to register an infant death either as a death or as a birth was confirmed by survey results: among all unregistered infant deaths, 86 percent were not registered as births either. This percentage was 94 among infant deaths below one month of age, 88 and 83 respectively among those who died at age one and two months, 60 percent among infants dying between the ages of 3-5 months, and 43 percent among infants who died in the age range 6-11 months.

GENERAL COMMENTS

While the above findings appear reasonable and acceptable, it must be emphasized that there are several unanswered questions regarding the accuracy of the data. One unknown is the adequacy of the sample selected in each region. There is also uncertainty about the matching procedures, specifically the extent to which cases whose registered names differed from those reported in the interviews were investigated (procedure c noted above). The practice of de jure instead of de facto registrations causes another problem. Although the law requires that a birth be registered in the locality where it occurred, (and naturally a small percentage of families do so even though they reside elsewhere), for mothers who delivered in a sample area but live elsewhere the completeness of registration of their births is difficult to assess, in part because many of these mothers were not available for interview.

Glossary

AGE HEAPING A tendency for enumerators or respondents to report certain ages instead of others; also called age preference or digit preference. Preference for ages ending in 0 or 5 is widespread.

AGE PATTERN OF FERTILITY The relative distribution of a set of age-specific fertility rates. It expresses the relative contribution of each age group to total fertility.

AGE RATIO The ratio of the population in a given age group to the average of the populations in the two neighboring age groups, times 100.

AGE-SPECIFIC FERTILITY RATE The number of births occurring during a specified period to women of a specified age or age group, divided by the number of person-years-lived during that period by women of that age or age group. When an age-specific fertility rate is calculated for a calendar year, the number of births to women of the specified age is usually divided by the midyear population of women of that age.

AGE-SPECIFIC MORTALITY RATE The number of deaths occurring during a specified period to persons (usually specified by sex) of a specified age or age group, divided by the number of person-years-lived during that period by the persons of that age or age group. When an age-specific mortality rate is calculated for a calendar year, the number of deaths to persons of the specified age is usually divided by the midyear population of persons of that age. Age-specific mortality rates are generally denoted by $_nM_x$, the annual death rate to persons aged x to x + n.

AGE STANDARDIZATION A procedure of adjustment of crude rates (birth, death, or other rates) designed to

reduce the effect of differences in age structure when comparing rates for different populations.

BIRTH HISTORY A report of the number and dates of all live births experienced by a particular woman; see also pregnancy history. The sex of each child, the survival of each child to the date of the interview, and, where pertinent, the date of death are also generally recorded.

BIRTH ORDER The ordinal number of a given live birth in relation to all previous live births of the same woman (e.g., 5 is the birth order of the fifth live birth occurring to the same woman).

BIRTH RATE See crude birth rate.

CHANDRASEKARAN-DEMING TECHNIQUE A procedure to estimate the coverage of two independent systems collecting information about demographic or other events, based on the assumption that the probability of an event being recorded by one system is the same whether or not the event is recorded by the other system. The events from both systems are matched to establish M, the number of events recorded by both systems; U_1, the number recorded only by system 1; and U_2, the number recorded only by system 2. The Chandrasekaran-Deming formula then estimates total events, N, as

$$\hat{N} = M + U_1 + U_2 + \frac{U_1 U_2}{M}.$$

CHILDBEARING AGES The span within which women are capable of bearing children, generally taken to be from age 15 to age 49 or, sometimes, to age 44.

CHILDREN EVER BORN(E) The number of children ever borne alive by a particular woman; synonymous with parity. In demographic usage, stillbirths are specifically excluded.

COHORT A group of individuals who experienced the same class of events in the same period. Thus an age cohort is a group of people born during a particular period, and a marriage cohort is a group of people who married during a particular period. The effects of a given set of mortality or fertility rates are often illustrated by applying them to hypothetical cohorts.

COHORT FERTILITY The fertility experienced over time by a group of women or men who form a birth or a marriage cohort. The analysis of cohort fertility is contrasted with that of period fertility.

CRUDE BIRTH RATE The number of births in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as births per 1,000 population. The crude birth rate for a single year is usually calculated as the number of births during the year divided by the midyear population.

CRUDE DEATH RATE The number of deaths in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as deaths per 1,000 population. The crude death rate for a single year is usually calculated as the number of deaths during the year divided by the midyear population.

CUMULATED FERTILITY An estimate of the average number of children ever borne by women of some age x, obtained by cumulating age-specific fertility rates up to age x; also often calculated for age groups.

DEATH RATE See crude death rate.

DE FACTO POPULATION A population enumerated on the basis of those present at a particular time, including temporary visitors and excluding residents temporarily absent. See de jure population.

DE JURE POPULATION A population enumerated on the basis of normal residence, excluding temporary visitors and including residents temporarily absent. See de facto population.

DIGITAL PREFERENCE See age heaping.

DUAL RECORD SYSTEM See Chandrasekaran-Deming Technique

EXPECTATION OF LIFE AT BIRTH The average number of years that a member of a cohort of births would be expected to live if the cohort were subject to the mortality conditions expressed by a particular set of age-specific mortality rates. Denoted by the symbol e(o) in life table notation.

FERTILITY HISTORY Either a birth history or a pregnancy history.

FORWARD SURVIVAL A procedure for estimating the age distribution at some later date by projecting forward an observed age distribution. The procedure uses survival ratios, often obtained from model life tables. The procedure is basically a form of population projection without the introduction of new entrants (births) to the population.

GENERAL FERTILITY RATE The ratio of the number of live births in a period to the number of person-years-lived by women of childbearing ages during the period. The

general fertility rate for a year is usually calculated as the number of births divided by the number of women of childbearing ages at midyear.

GROSS REPRODUCTION RATE The average number of female children a woman would have if she survived to the end of her childbearing years and if, throughout, she were subject to a given set of age-specific fertility rates and a given sex ratio at birth. This number provides a measure of replacement fertility in the absence of mortality.

GROWTH RATE The increase or decrease of a population in a period divided by the number of person-years-lived by the number of person-years-lived by the population during the same period. The increase in a population is the result of a surplus (or deficit) of births over deaths and a surplus (or deficit) of immigrants over emigrants. (The annual increase is often expressed as a fraction of the total population at the beginning of the year, but this convention has the inconvenient characteristic of not being readily defined for a five-year interval and of being unequal to the difference between the birth rate and the death rate even in the absence of migration.) See also rate of natural increase.

INFANT MORTALITY RATE The number of deaths of children under 1 year of age occurring in the same year; also used in a more rigorous sense to mean the number of deaths that would occur under 1 year of age in a life table with a radix of 1,000, in which sense it is denoted by the symbol $_1q_0$.

LIFE TABLE A listing of the number of survivors at different ages (up to the highest age attained) in a hypothetical cohort subject from birth to a particular set of age-specific mortality rates. The rates are usually those observed in a given population during a particular period of time. The survivors of the radix to age x are generally denoted by $l(x)$. The tabulations commonly accompanying a life table include other features of the cohort's experience: its expectation of life at each age x, denoted by $e(x)$; the probability of surviving from each age x to age $x + n$, denoted by $_nq_x$; the person-years-lived by the hypothetical cohort as it ages from age x to age $x + n$, denoted by $_nL_x$ (also equivalent to the population aged $x, x + n$ in a stationary population experiencing a number of births each year equal to the radix of the life table); and the person-years-lived

by the hypothetical cohort from age x onward, denoted by T(x).

LOGIT The logit of a proportion p is 1/2 ln[p/(1 - p)]. As a linearizing transformation, the logit has been proposed as the basis of a model life table system in which the logit of a probability of dying by age x (${}_xq_0$) is related linearly to the logit of a standard probability of dying by age x (${}_xq_0^s$) so that

$$\text{logit}\ ({}_xq_0) = \alpha + \beta\ [\text{logit}\ ({}_xq_0^s)],$$

where α is a measure of mortality level relative to the standard and β is a parameter that alters the shape of the standard mortality function.

MARITAL FERTILITY Any measure of fertility in which the births (in the numerator) are births to married women and in which the number of person-years-lived (in the denominator) also pertains to married women. In some instances, the designation "married" includes persons in consensual unions.

MEDIAN The value associated with the central member of a set that is ordered by size or some other characteristic expressed in numbers.

MEAN AGE OF CHILDBEARING The average age at which a mortality-free cohort of women bear their children according to a set of age-specific fertility rates.

MEAN AGE OF CHILDBEARING IN THE POPULATION The average age of the mothers of the children born in a population during a year. This measure incorporates the effects of both mortality and the age distribution.

MIGRATION RATE Number of migrants during a specified period divided by the person-years-lived of the population exposed to migration. Also see population change due to migration.

MODEL LIFE TABLE An expression of typical mortality experience derived from a group of observed life tables.

MOVING AVERAGES The successive averaging of two or more adjacent values of a series in order to remove sharp fluctuations.

MYERS INDEX An index of digit preference that essentially sums in turn the population ending in each digit over some age range, often 10-89, expressing the total as a percentage of the total population, and which avoids the bias introduced by the fact that the population is not evenly distributed among all ages by repeating the calculations 10 times, once for each

starting digit, and averaging the results. The difference between the average percentage for each digit and the expected value of 10 percent provides a measure of the preference for or avoidance of the digit over the age range considered.

NATURAL FERTILITY The age pattern of *marital fertility* observed in non-contraceptive populations where reproductive behavior is not affected by the number of children already born.

NET MIGRATION The difference between gross immigration and gross emigration.

NET REPRODUCTION RATE The average number of female children born per woman in a *cohort* subject to a given set of *age-specific fertility rates*, a given set of *age-specific mortality rates*, and a given *sex ratio at birth*. This rate measures replacement fertility under given conditions of fertility and mortality: it is the ratio of daughters to mothers assuming continuation of the specified conditions of fertility and mortality.

OWN-CHILDREN METHOD A refinement of the *reverse-survival* procedure for fertility estimation, whereby estimates of *age-specific fertility rates* for the recent past are obtained by relating mothers to their own children, using information on relationship and other characteristics available from a census or survey.

PARITY See *children ever born*.

PARTIAL BIRTH RATE The proportion of the population that enters (that is, is "born" into) a given age category in a year. The age categories used are normally open-ended, thus the partial birth rate x+ designates the proportion of the population becoming x years and older.

PARTIAL DEATH RATE The proportion of the population that leaves (that is, "dies" out of) a given age category in a year. See *partial birth rate*.

PERIOD FERTILITY The fertility experienced during a particular period of time by women from all relevant birth or marriage *cohorts*; see also *cohort fertility*.

P/F RATIO METHOD A consistency check for survey information on fertility. Information on recent fertility is cumulated to obtain measures that are equivalent to average parities. Lifetime fertility in the form of reported average parities by age group (P) can then be compared for consistency with the parity-equivalents (F) by calculating the ratio P/F for successive age groups. If certain assumptions

about error patterns are met, an improved estimate of fertility can sometimes be obtained by correcting the age pattern of current fertility to agree with the level of lifetime fertility reported by younger women.

POPULATION CHANGE DUE TO MIGRATION The sum of in-migrants minus out-migrants during a specified period of time. The change may also be expressed as a rate by dividing the change by person-years-lived in the population during the same period.

PREGNANCY HISTORY A report of the number and the dates of occurrence of all the pregnancies experienced by a particular woman. The outcome of the pregnancy--live birth, stillbirth, fetal death--is also recorded.

RADIX The hypothetical birth cohort of a life table. Common values are 1, 1,000, and 100,000.

RATE OF NATURAL INCREASE The difference between the births and deaths occurring during a given period divided by the number of person-years-lived by the population during the same period. This rate, which specifically excludes changes resulting from migration, is the difference between the crude birth rate and the crude death rate.

RETROSPECTIVE SURVEY A survey that obtains information about demographic events that occurred in a given past period, generally terminating at the time of the survey.

REVERSE PROJECTION See reverse survival.

REVERSE SURVIVAL A technique to estimate an earlier population from an observed population, allowing for those members of the population who would have died according to observed or assumed mortality conditions. It is used as a method of estimating fertility by calculating from the observed number of survivors of a given age x the expected number of births that occurred x years earlier. (In situations for which both fertility and mortality are known or can be reliably estimated, reverse survival can be used to estimate migration.)

ROBUSTNESS A characteristic of estimates that are not greatly affected by deviations from the assumptions on which the estimation procedure is based.

SEX RATIO AT BIRTH The number of male births for each female birth, or male births per 100 female births.

SINGULATE MEAN AGE AT MARRIAGE (SMAM) A measure of the mean age at first marriage, derived from a set of proportions of people single at different ages or in

TABLE F-2 Underregistration of Deaths by Region, 1974-75: Egypt

Region	Total Sample Population	Number of Deaths				Estimated Under-registration (percent)
		Recorded in Survey and in Registration System	Recorded in Registration System Only	Recorded in Survey Only	Total	
Cairo and Alexandria	54,314	502	11	7	520	1.35
Urban Lower Egypt	87,492	807	98	62	967	6.41
Urban Upper Egypt	66,740	892	69	115	1,076	10.69
Rural Lower Egypt	265,380	3,052	492	360	3,904	9.22
Rural Upper Egypt	221,200	2,411	479	1,122	4,012	27.97
All Egypt (weighted)[a]						12.83

[a] The weights are the total deaths in 1974-75 as given in the vital statistics of the registration system.

TABLE F-3 Underregistration of Infant Deaths by Region, 1974-75: Egypt

Region	Total Sample Population	Number of Infant Deaths				Estimated Under-registration (percent)
		Recorded in Survey and in Registration System	Recorded in Registration System Only	Recorded in Survey Only	Total	
Cairo and Alexandria	54,314	95	33	5	133	3.76
Urban Lower Egypt	87,492	179	17	35	231	15.15
Urban Upper Egypt	66,740	248	15	88	351	25.07
Rural Lower Egypt	265,380	578	42	262	882	29.71
Rural Upper Egypt	221,200	481	36	645	1,162	55.51
All Egypt (weighted)[a]						33.46

[a] The weights are the total infant deaths in 1974-75 as given in the vital statistics of the registration system.

different age groups, usually calculated separately for males and females.

STABLE POPULATION A population exposed for a long time to constant fertility and mortality rates, and closed to migration, establishes a fixed age distribution and constant growth rate characteristic of the vital rates. Such a population, with a constant age structure and constant rate of growth, is called a stable population.

STATIONARY POPULATION A stable population that has a zero growth rate, with constant numbers of births and deaths per year. Its age structure is determined by the mortality rates and is equivalent to the person-years-lived (${}_nL_x$) column of a conventional life table.

SURVIVAL RATIO The probability of surviving between one age and another; often computed for age groups, in which case the ratios correspond to those of the person-years-lived function, ${}_nL_x$, of a life table. Also called survivorship probabilities.

SURVIVORSHIP PROBABILITIES See survival ratio.

SYNTHETIC PARITY The average parity calculated for a hypothetical cohort exposed indefinitely to a set of period age-specific fertility rates.

TOTAL FERTILITY RATE (TFR) The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given set of age-specific fertility rates; also referred to as total fertility. It is frequently used to compute the consequence of childbearing at the rates currently observed.

UNITED NATIONS AGE-SEX ACCURACY INDEX An index of age reporting accuracy that is based on deviations from the expected regularity of population size and sex ratio, age group by age group. The index is calculated as the sum of (1) the mean absolute deviation from 100 of the age ratios for males, (2) the mean absolute deviation from 100 of the age ratios for females, and (3) three times the mean of the absolute difference in reported sex ratios from one age group to the next. The United Nations defines age-sex data as "accurate," "inaccurate," or "highly inaccurate" depending on whether the index is less than 20, 20 to 40, or greater than 40.

WHIPPLE'S INDEX A measure of the quality of age reporting based on the extent of preference for a particular target digit or digits. The index

essentially compares the reported population at ages ending in the target digit or digits with the population expected on the assumption that population is a linear function of age. For a particular age range, often 23 to 62, the population with ages ending in the target digits is divided by one-tenth of the total population, the result then being multiplied by 100 and divided by the number of different target digits. A value of 100 indicates no preference for those digits, whereas values over 100 indicate positive preference for them.

References

Brass, W., and A. Coale (1968) Methods of analysis and estimation. In W. Brass et al., The Demography of Tropical Africa. Princeton, N.J.: Princeton University Press.

Carrier, N. H. (1958) A note on the estimation of mortality and other population characteristics, given deaths by age. Population Studies 12(2):149-163.

Coale, A. J. (1965) Factors associated with the development of low fertility: an historic summary. In World Population Conference, 1965, Vol. II. New York: United Nations.

Coale, A. J. (1970) The decline of fertility in Europe from the French Revolution to World War II. In S. J. Behrman, L. Corsa, Jr., and R. Freedman, eds., Fertility and Family Planning: A World View. Ann Arbor, Mich.: The University of Michigan Press.

Coale, A. J. (1971) Age patterns of marriage. Population Studies 25(2):193-214.

Coale, A. J., B. R. Anderson, and E. Harm (1979) Human Fertility in Russia Since the Nineteenth Century. Princeton, N.J.: Princeton University Press.

Coale, A. J., L.-J. Cho, and N. Goldman (1980) Estimation of Recent Trends in Fertility and Mortality in the Republic of Korea. Washington, D.C.: National Academy of Sciences.

Coale, A. J., and T. J. Trussell (1974) Model fertility schedules: variations in the age structure of childbearing in human populations. Population Index 40(2):185-258.

Coale, A. J., and T. J. Trussell (1978) Technical note: finding the two parameters that specify a model schedule of marital fertility. Population Index 44(2):203-213.

Egypt*, Central Agency for Mobilisation and Statistics (CAPMAS) (n.d. a) Census of Population, 1976 (special tabulations). Cairo: CAPMAS.

Egypt*, Central Agency for Public Mobilisation and Statistics (CAPMAS) (n.d. b) Preliminary Results of the General Population and Housing Census, 22/23 November 1976 in Egypt. Cairo: CAPMAS.

Egypt*, Central Agency for Public Mobilisation and Statistics (CAPMAS) (1978) Population and Development. Cairo: CAPMAS.

Egypt*, Central Agency for Public Mobilisation and Statistics (CAPMAS) (1979) Statistical Yearbook, 1952-1978. Cairo: CAPMAS.

Egypt*, Central Agency for Public Mobilisation and Statistics (CAPMAS) (1981) Preliminary report based on trend tabulations of the 1980 Egyptian Fertility Survey, May.

Egypt*, Central Agency for Public Mobilisation and Statistics (CAPMAS) (various years) Birth and Death Statistics, 1976 and Divorce and Marriage Statistics, 1976. Cairo: CAPMAS. (Data have been obtained from this series for the years 1927 to 1939, 1943 to 1961, 1970 to 1976. For 1961 and earlier the series was titled Vital Statistics.)

Egypt*, Statistical and Census Department (1931) Population Census of Egypt, 1927. Cairo: Statistical and Census Department.

Egypt*, Statistical and Census Department (1942) Population Census of Egypt, 1937. Cairo: Statistical and Census Department.

Egypt*, Statistical and Census Department (1953-54) Population Census of Egypt, 1947. Cairo: Statistical and Census Department.

Egypt*, Department of Statistics and Census (1962-63) Census of Population, 1960. Cairo: Department of Statistics and Census.

El-Badry, M. A. (1961) Failure of enumerators to make entries of zero: errors in recording childless cases in population censuses. Journal of the American Statistical Association 56:909-924.

El-Badry, M. A. (1965) Trends in the components of population growth in the Arab countries of the Middle East. Demography 2:140-186.

*Official Egyptian publications appear under Egypt, United Arab Republic, or Arab Republic of Egypt. For simplicity only Egypt will be used here.

Issa, M. S. A. (1980) Modernization and the Fertility Transition, Egypt, 1975. Paper presented to the annual meeting of the Population Association of America, April 10-12, Denver, Colorado.

Preston, S., A. J. Coale, T. J. Trussell, and M. Weinstein (1980) Estimating the completeness of reporting of adult deaths in populations that are approximately stable. Population Index 46(2):179-202.

Sayed, Hussein Abdul Azis (1981) Regional Pattern of Differentials in Contraceptive Use in Egypt. Paper presented at the Cairo Demographic Center, December.

Sullivan, J. M. (1972) Models for the estimation of the probability of dying between birth and exact ages of early childhood. Population Studies 26(1):79-97.

Trussell, T. J. (1975) A re-estimation of the multiplying factors for the Brass technique for determining childhood survivorship rates. Population Studies 29(1):97-107.

United Nations Department of Economic and Social Affairs (1967) Manual IV: Methods of Estimating Basic Demographic Measures from Incomplete Data. Population Studies, No. 42. New York: United Nations.

World Bank (1979) World Development Report, 1979 (Annex: World Development Indicators). Washington, D.C.: World Bank.

Bibliography

Abdel-Aty, S. H. (1961) Life table functions for Egypt based on model life tables and quasi-stable population theory. The Milbank Memorial Fund Quarterly 39(2):350-377.

Abdou, S., and F. M. Lahib (1970) Changes in the trend of the crude birth rate and the crude death rate of Cairo and the U.A.R. during the past ten years (1958-1968). Journal of the Egyptian Medical Association 53:433-441.

Abu-Lughod, J. (1964) Urban-rural differences as a function of demographic transition: Egyptian data and an analytical model. American Journal of Sociology 69(5):476-490.

Abu-Lughod, J. (1965) The emergence of differential fertility in urban Egypt. The Milbank Memorial Fund Quarterly 43(2):235-253.

Abu-Lughod, J., and Attiya, Ess el-Din (1963) Cairo Fact Book. Cairo: Social Research Center, American University in Cairo. (In English and Arabic.)

Ahmed, Ferial A. K. (1971) Fertility trends in Egypt and their effect on population growth. In Fertility Trends and Differentials in Arab Countries. Cairo Demographic Center. Research Monograph No. 2.

Ahmed, Ferial A. K. (1972) Fertility Studies in the Arab Republic of Egypt. Working group on Fertility Levels and Differentials in Africa and Prospects for the Future. United Nations Economic Commission for Africa, POP/INF/110. Addis Ababa. December 18-22.

al-Dali, 'Abd-al-Hamid (1955) al-'Anasir al-haya wiyah li mushlikat al-sukkan fir Misr (Vital elements in the problems of population in Egypt). Cairo, Maktabat al-Nahdah al-Misriyyah.

al-Husayni, al-Sayyid M. (1976) al-Tabagah al-ijtima iyyah wa-al-suluk al-injabi (Social class and fertility behavior). Population Studies (Cairo) 33:1-78 (English summary, pp. 1-4).

Al-Sayyad, Muhammad Mahmud (1951) Sukkan Mudiriyyat al-Buhayrah fi khamsin 'am (1897-1947) (The population of Behera Province during fifty years [1897-1947]). Majallat Kulliyyat al-'Adab (Cairo) 13(1)87-121; 13(2)157-183.

Ammar, A. M. (1942) A Demographic Study of an Egyptian Province (Sharqiya). London: London School of Economics and Political Science.

Ammar, A. M. (1944) The People of Sharqiya: Their Racial History, Serology, Physical Character(istic)s, Demography and Conditions of Life, Vol. 1. Cairo: Publications de la Societe Royale de Geographie D'Egypte.

Ammar, H. (1954) Growing Up in an Egyptian Village: Silwa, Province of Aswan. London: Routledge and Kegan Paul Ltd.

Arab Republic of Egypt, Central Agency for Public Mobilisation and Statistics (CAPMAS) (1972) Demographic situation in Egypt. Population Researches and Studies 1 (July):1-24.

Arab Republic of Egypt, Central Agency for Public Mobilisation and Statistics (CAPMAS) (1979) Measurement of Under-registration of Vital Events Sample Survey. Mimeo. Cairo.

Arab Republic of Egypt, Central Agency for Public Mobilisation and Statistics (CAPMAS) (1979) The National Fertility Survey, 1964-1975: Abridged Tabulations on Fertility for Surveyed Women in the Reproductive Age. Mimeo. April 4. Cairo.

Arab Republic of Egypt, Central Agency for Public Mobilisation and Statistics (CAPMAS) (1979) A Statement on the Population of the Arab Republic of Egypt. Mimeo. June 9. Cairo.

Arab Republic of Egypt, Central Agency for Public Mobilisation and Statistics (CAPMAS) (n.d.) The National Fertility Survey Objectives, Organization and Methodology 1974, 1975: Egypt. Mimeo. Cairo.

Arab Republic of Egypt, Central Agency for Public Mobilisation and Statistics (CAPMAS) (n.d.) The Preliminary Results of the General Population and Housing Census, 22/23 November 1976 in Egypt. Mimeo. Cairo.

The following entries have also been published by CAPMAS, although the country name was the United Arab Republic in some years and the Arab Republic of Egypt in other years. (See also the separate listings under United Arab Republic.)

CAPMAS (annual) A.R.E. Statistical Indicators. (1952-1972 edition published 1973.) Cairo.

CAPMAS (annual) Birth and Death Statistics. (In Arabic.) Cairo.

CAPMAS (annual) Divorce and Marriage Statistics. (In Arabic.) Cairo.

CAPMAS (annual) Health Services Statistics. (In Arabic.) Cairo.

CAPMAS (quarterly) Population Movement Across Egyptian Borders. (In Arabic.) Cairo.

CAPMAS (1965) Basic Statistics 1964. Cairo.

CAPMAS (1966) Population Growth in the U.A.R. - A Challenge to Development. Cairo.

CAPMAS (1967) Evaluation of Published Birth and Infant Mortality Data in Different Areas of the U.A.R. Ref (01-210). (In Arabic.) Cairo.

CAPMAS (1967) Tadrij ahad al-sinn Fi al-jumhurija al-'Arabija (One Classification of Age in the United Arab Republic). Cairo.

CAPMAS (1976) Al-Nata'ij al-niha'iyah li-ta'dad al-sukkan bi-al-'ayyinah'am 1976. (Final results of the sample population census of 1976). Cairo.

CAPMAS (1968) Annuaire Statistique, Republique Arabe Unie, 1952-1967. Cairo.

CAPMAS (1969) Statistical Handbook, United Arab Republic 1952-1968. Cairo.

CAPMAS (1969) Statistical Abstract of the United Arab Republic. Cairo.

CAPMAS (1970) Statistical Handbook: United Arab Republic 1952-1969. Cairo.

CAPMAS (1971) Population Researches and Studies, Vol. 1, No. 1. Contains fertility trends in U.A.R. by Governorates, I.M.R. by sex and age, and changes in numbers of births. Cairo.

CAPMAS (1972) Statistical Handbook, Arab Republic of Egypt, 1952-1971. Cairo.

CAPMAS (1973) Collection of Vital Statistics for the U.A.R. of Egypt since 1930. Ref (01-100). (In Arabic.)

CAPMAS (1973) Differental age-specific fertility rates in A.R.E. (1968-1970). Population Researches and Studies 7:54-80. (In Arabic, English summary.)

CAPMAS (1975) The decline of birth rates in Egypt since 1964. Population Researches and Studies 11 (Cairo).

CAPMAS (1975) Fertility by order of birth in Egypt (1963-1972). Population Researches and Studies 11 (Cairo).

CAPMAS (1977) Preliminary results of the 1976 Egyptian general population and housing census. Egyptian Population and Family Planning Review, (Cairo) 11(1-2):90-95.

CAPMAS (1978) Population and Development: A Study on the Population Increase and its Challenge to Development in Egypt. Cairo: CAPMAS.

Ascadi, G., and M. S. Issa (1975) Considerations on Arabic Model Life Tables and Egyptian Mortality. Paper presented at the Cairo Demographic Centre Seminar on Mortality Trends and Differentials in Some Arab and African Countries, December 17-23, Cairo.

Bedwani, Kamal N. (1973) The effects of fertility on economically active population: Egypt (1960-1975). The Egyptian Population and Family Planning Review (Cairo) 6(1):25-31.

Bindary, Aziz, et al. (1979) Urban-rural differences in the relationship between women's employment and fertility: a preliminary study. Journal of Biosocial Science 5(2):159-167.

Burden, S. K. (1973) Population movements and distribution over time and space. Pp. 115-130 in A. R. Omran, ed., Egypt: Population Problems and Prospects. Chapel Hill, N.C.: Carolina Population Center.

Cairo Demographic Center (1970) Demographic Measures and Population Growth in Arab Countries. Research Monograph Series, No. 1. Cairo: Cairo Demographic Center.

Cairo Demographic Center (1970) Fertility Trends and Differentials in Arab Countries. Research Monograph Series, No. 1. Cairo: Cairo Demographic Center.

Cairo Demographic Center (n.d.) Considerations on an Arab Model Life Table and the Egyptian Mortality Research Monograph Series, No. 6. Cairo: Cairo Demographic Center.

Cairo Demographic Center (1976) Determinants of Fertility Differentials Among Female Teachers in Egypt. Research Monograph Series, No. 7. Cairo: Cairo Demographic Center.

Carrier, N. H., and A. M. Farrag (1959) The reduction of errors in census populations for statistically underdeveloped countries. Population Studies 12(3):240-285.

Chasteland, A. C., and L. Seraydarian (1972) Situation demographique dans les pays du Moyen-Orient et dans la Republique Arabe d'Egypte. Proche-Oriente Etudes Economiques (Beirut) 73:293-344.

Croley, H. T. (1969) United Arab Republic. Country Profiles Series. New York: International Institute for the Study of Human Reproduction, The Population Council and Columbia University.

Drosso, F. (1979) Evaluation des Effectifs de la Population des Pays Africains: Egypte. Monograph 12. Group de Demographie Africaine. Paris.

Ducruet, Jean (1967) Statistiques et perspectives demographiques en Republique Arabe Unie. Proche-Orient Etudes Economiques (Beirut):49-121.

Egypt, Bureau of Census and Statistics (1937) 1937 Population Census, Vol. 1. Cairo (15 books, variously paged).

Egypt, Bureau of Census and Statistics (1942?) Births and Deaths Per Village, 1937-1941. Cairo: Government Press.

Egypt, Census Department (1953) Population Census, 1947, Part 2, General Tables. Cairo: Government Press. (In Arabic.)

Egypt, Department de la Statistique et du Recensement (annual) Statistical Yearbook, Volumes 1942-45, 1952-74. Cairo: Imprimerie Nationale.

Egypt, Ministere des Finances, Department de la Statistique et du Recensement (1948, 1951) Annuaire Statistique, 1944-1945, 1945-1946, and 1946-1947, 3 vols. Le Caire: Imprimerie Nationale.

Egypt, Ministry of Finance and Economy, Statistics and Census Department (1951-54) Population Census of Egypt, 1947. Cairo: Government Press.

Egypt, Ministry of Finance, Statistical Department (1952) Statistical Pocket Year-book, 1952. Cairo: Government Press.

Egypt, Ministry of Public Health (1946) Annual Report 1939. Cairo: Government Press.

Egypt, Ministry of Public Health (1947) Annual Report on the Work of the Ministry of Public Health for the Year 1941. Cairo: Government Press.

Egypt, Population and Family Planning Board (1979) Egyptian Population Studies: Annotated Bibliography.

Sarah F. Loza, ed. (In 2 Vols.: Vol. 1 in Arabic, Vol. 2 in English.) Cairo.

Egypt, Statistical and Census Department (1942) *Population Census of Egypt, 1937*, General Tables. Cairo: Government Press.

Egypt, Statistical and Census Department (1947) *Population Census, 1947*. First part of the census manuals of the 17 Egyptian Governorates and Provinces for 1947.

Egypt, Statistical Department (1942) *Fourth Quarterly Return of Births, Deaths, Infectious Diseases, Marriage and Divorce, 1941*. Cairo: Government Press.

Egypt, Statistical Department (1951) *Census of Population, 1947*. Reproduced by the Food and Agriculture Organization of the United Nations. Cairo: FAO Near East Regional Office.

Egypt, Statistical Department (1952) *Census of Population, 1947*. Reproduced by the Food and Agriculture Organization of the United Nations. Cairo: FAO Near East Regional Office.

Egypt, Statistical Department (1954) *Statistical Pocket Year-Book, 1953*. Cairo: Government Press.

El-Attar, M. E. (1973) Differential fertility in the A.R. of Egypt. *Social Biology* 20(3):323-334.

El-Badry, M. A. (1955) Some demographic measurements for Egypt based on the stability of census age distributions. *The Milbank Memorial Fund Quarterly* 33(3):268-305.

El-Badry, M. A. (1956) Some aspects of fertility in Egypt. *The Milbank Memorial Fund Quarterly* 34(1):22-34.

El-Badry, M. A. (1965) Trends in the components of population growth in the Arab countries of the Middle East: a survey of present information. *Demography* 2:140-186.

El-Badry, M. A., and H. Rizk (1967) Regional fertility differences among socio-economic groups in the United Arab Republic. Pp. 137-141 in United Nations Department of Economic and Social Affairs, *Proceedings of the World Population Conference: Belgrade*, Vol. II. New York: United Nations.

El-Din Hamza, Ali, et al. (1973) The relationship between infant mortality and crude birth rates in Alexandria (1966-1971). *The Egyptian Population and Family Planning Review* 6(2):105-109.

El Hosseiny, El-Sayed M. (1974) Rural-urban differences in some demographic characteristics: a statistical analysis. *Population Studies* (Cairo) 9 (June):23-41.

El-Nomrossey, M. M. (1971) The Demographic Picture of the U.A.R. Institute of National Planning. Unpublished. Cairo.

Farag, A. A. (1971) Registration of births in A.R.E. *Population Researches and Studies* 1(October):7-11.

Farrag, A. M. M. (1970) Remarriages, multiple marriages, and polygamous nuptiality tables in the United Arab Republic, 1960. *The Egyptian Population and Family Planning Review* 3(2):101-110.

Fergany, Nader A. (1970) *On the Macro-Dynamic Stochastic Treatment of the Size and Age Structure of a Human Population*. Institute of Statistics, Consolidated University of North Carolina, Mimeo Series, 666. Chapel Hill, N.C.: Department of Biostatistics, University of North Carolina.

Fergany, Nader (1976) A Reconstruction of some Aspects of the Demographic History of Egypt in the Twentieth Century. Technical Papers (R/31) DPA, Computer Center. The American University at Cairo.

Fergany, Nader (1976) Prospects of long-range population growth and some related characteristics in Egypt. *Egypte Contemporaine* (Cairo) 67:193-211.

Fergany, Nader (1976) Sample estimates of crude birth and death rates in rural and urban areas of Egypt for 1973 and 1974. *Population Studies* (Cairo) 29:1-12.

Grais, M., et al. (1956) The role of mortality in recent population trends in Egypt. *Journal of the Egyptian Public Health Association* (Cairo) 31(4-5):155-195.

Hammound, E. I. (1963) A methodological study of underregistration of tuberculosis mortality in Egypt (UAR). *Journal of Chronic Diseases* 16(September): 991-1011.

Hammound, E. T. (1965) Effect of mis-reporting age of infant at death on age-specific mortality rates - a pilot study. *Journal of Egyptian Public Health Association* (Cairo) 40:459-482.

Hansen, B., and G. A. Marzouk (1965) The demographic picture. In *Development and Economic Policy in the U.A.R. (Egypt)*. (Also: appendix to chapter, entitled "Marriage rates and cumulative fertility, relating annual marriage rates 1938-1960 to fertility data of the 1947 and 1960 censuses.") Amsterdam: North-Holland Publishing Co.

Hollingsworth, T. H. (1972) The Egyptian birth rate and its sex ratio. *The Egyptian Population and Family Planning Review* 5(2):115-130.

Heun, Irene (1964) Die agypstische Ehe [Egyptian Marriage]. *Afrika Heute* (Bonn) 15:190-195.

Husein, H. M. (1956) Contributions to demography through new census inquiries. *Review of Economics, Politics and Business Studies* (Cairo) 4(1)February.

Husein, H. M., and A. E. Sarhan (1970) Effect of urbanization on population structure in U.A.R. *The Egyptian Population and Family Planning Review* 3(2):41-47.

International Statistical Institute (1954) *Population and Vital Statistics of Large Towns, 1946-1951*. Series A-Population, No. 1. The Hague: International Statistical Institute. (In English and French.)

Issa, Mahmoud S. A. (1972) An analysis of exogenous and endogenous infant mortality in Egypt. *Population Researches and Studies* 1(2):1-24.

Issa, Mahmoud S. A. (1976) A time series analysis of marriages in Egypt, 1962-1973. Pp. 373-390 in S. A. Huzayyin and G. T. Ascadi, eds., *Family and Marriage in Some African and Asiatic Countries*. Research Monographs Series, No. 6. Cairo: Cairo Demographic Center.

Issa, Mahmoud S. A. (1980) Modernization and the Fertility Transition, Egypt, 1975. Paper presented to the annual meeting of the Population Association of America, April 10-12, Denver, Colo.

Issawi, Charles (1963) *Egypt in Revolution: An Economic Analysis*. Issued under auspices of The Royal Institute of International Affairs. London: Oxford University Press.

Jurkat, E. (1944) Prospects for population growth in the Near East. In *Demographic Studies of Selected Areas of Rapid Growth*. New York: Milbank Memorial Fund.

Kamal, Wasfia H., et al. (1968) A fertility study in Al-Amira. *The Egyptian Population and Family Planning Review* 1(2):83-100.

Khalifa, Atef M. (1972) Towards a computerized demographic microsimulation model for Egypt: experimentation of POPSIM, Part 1. *The Egyptian Population and Family Planning Review* 5(2)153:166

Khalifa, Atef M. (1973) A proposed explanation of the fertility gap differentials by socioeconomic status and modernity: the case of Egypt. *Population Studies* (London) 27(3):431-442.

Khalifa, Atef M., and M. G. El-Rouby (1973) Population and aging in Egypt: past and future trends. *The Egyptian Population and Family Planning Review* 6(1):51-73.

Khalifa, Atef M., and Hoda Rachad (1972) A model for human reproduction: the case of Egypt. The Egyptian Population and Family Planning Review 5(2):99-114.

Khalifa, A. M., et al. (1973) The Population of the Arab Republic of Egypt. CICRED. Cairo: Cairo University.

Khalifa, Atef M. (1974) The population of the Arab Republic of Egypt. The Egyptian Population and Family Planning Review 7(2):53-78.

Khalifa, Atef M. (1976) The influence of wife's education on fertility in rural Egypt. Journal of Biosocial Science 8(1):53-60.

Khalifa, A. M. (1978) Rural-urban fertility differences and trends in Egypt, 1930-1970. Pp. 77-94 in J. Allman, ed., Women's Status and Fertility in the Muslim World. New York: Praeger Publishers.

Khodary, M. S., et al. (1970) Use of census age distributions for estimating basic demographic parameters of the U.A.R. (Egypt). Pp. 249-277 in Demographic Measures and Population Growth in Arab Countries. Research Monograph Series, No. 1. Cairo: Cairo Demographic Center.

Kiser, C. V. (1944) The demographic position of Egypt. Pp. 97-122 in Demographic Studies of Selected Areas of Rapid Growth. New York: Milbank Memorial Fund.

Marzouk, Girgis A. (1957) Fertility of the urban and rural population in Egypt. L'Egypte Contemporaine (Cairo) 48(287):27-34. (Arabic text: pp. 79-88.)

Mina, S. F., A. A. Gamry, et al. (1971) Fertility trends in A.R.E. by governorates (1966-69). Population Researches and Studies 1 (October):12-47. (In Arabic.)

Morcors, Wedad (1974) Employment of women and fertility: a field study in el-Waily district, Cairo. The Egyptian Population and Family Planning Review 7(1):21-29.

Moussa, Abd el-H. (1972) Differential death rates by age groups and governorates in A.R.E. (Arabic with English summary). Population Researches and Studies (Cairo) 1(2):3-68.

Moustafa, Medany D., et al. (1971) Models for infant mortality in developed and developing countries with application to A.R.E. The Egyptian Population and Family Planning Review 4(2):35-68.

Nahas, M. Kamel (1954) The family in the Arab world. Marriage and Family Living 16(4):293-404.

Namiq, Salah al-Din (1972) Mushkilat al-sukkan fi misr (The population problem in Egypt). Dar al-Nahda al-Arabia. Cairo.

Nortman, D. (1970, 1971, 1972) *Population and Family Planning Programs: A Factbook*. Reports on Population/Family Planning, No. 2 (second, third, and fifth editions). New York: The Population Council.

Nortman, D., and E. Hofstatter (1975, 1978, 1980) *Population and Family Planning Programs: A Factbook*. Reports on Population/Family Planning, No. 2 (seventh, ninth, and tenth editions). New York: The Population Council.

Nosseir, Nazek Khalil (1975) Measures of Fertility and Mortality in the Governorates of Egypt, 1947 and 1960. Ph.D. dissertation, Princeton University.

Omran, Abdel R., ed. (1973) *Egypt: Population Problems and Prospects*. Chapel Hill, N.C.: Carolina Population Center.

Petersen, Karen K. (1968) Demographic conditions and extended family households: Egyptian data. *Social Forces* 46(4):531-537.

Platt, R. R., and M. B. Hefny (1958) *Egypt: A Compendium*. Handbook No. 2. New York: American Geographical Society.

Polish Academy of Sciences, National Research Centre; and United Arab Republic, Ministry of Scientific Research (1964) Scientific elaboration of some selected problems of population in the United Arab Republic (Egypt). *Publications of the Joint Arabic-Polish Anthropological Expedition 1958/1959, Part 2*. Warsaw, Poznan, and Cairo.

Population Council (1974) *Country Prospects: Arab Republic of Egypt*. New York: The Population Council.

Rizk, H. (1973) Social and psychological factors affecting fertility in the United Arab Republic. *Marriage and Family Living* 25(1):69-73.

Safwat, Mahmud Muhammad (1967) *Al-Ihsa at al-Hayawiyah* (Vital Statistics in the United Arab Republic). Cairo: Dar al-kateb al-arabi lil-tabba at wa-al-nashi.

Saliman, Hosny, and El Faal, Mohamed A. (1972) Differential family size in urban and rural A.R.E. in 1966 (Arabic with English summary). *Population Researches and Studies* (Cairo) 1(2):69-80.

Samra, Metwally A. A. H. (1972) On the estimation and precision of the main characteristics of the population in 1966 micro-population census in the A.R.E., Part 1. *Population Researches and Studies* (Cairo) 1(2):25-29.

Sayed, H. A. (1977) A new approach for the estimation of births underregistration, Egypt: 1920-1970. *The*

Egyptian Population and Family Planning Review (Cairo) 11(1-2):44-71.

Sayed, H. A. A. (1970) Comparative Study of Infant Mortality Types in the U.A.R. and Some Developed Countries. Unpublished M.Sc. thesis, Faculty of Economic and Political Science, Cairo University.

Sayed, H. A. A. (1976) Fertility and Nuptuality in Egypt: A Statistical Study with Computer Modelling. Unpublished Ph.D thesis, The City University, London.

Sayed, H. A. A. (1977) Evaluation of Egyptian Fertility, Background and Framework for Analysis. Technical Papers. R(72). D.P.A. Computer Center, American University, Cairo.

Schultz, T. P., assisted by J. DaVanzo (1970) Fertility Patterns and their Determinants in the Arab Middle East. RM-5978-FF. Rand Corporation.

Schultz, T. P. (1972) Fertility patterns and their determinants in the Arab Middle East. In C. A. Cooper, and S. S. Alexander, eds., Economic Development and Population Growth in the Middle East. New York: American Elsevier.

Shaaban, A. H., and F. M. Labib (1970) Fertility and fecundity in the U.A.R. as compared with other countries. Journal of the Egyptian Medical Association 53:538-549.

United Arab Republic, Statistical Department (1959) Vital Statistics: Births and Deaths in Localities with Health Bureaus, Vol. I, 1954. Cairo: Government Printing Offices.

United Arab Republic, Department of Statistics and Census (annual) Vital Statistics. Cairo: Government Printing Offices. (In English and Arabic. Years available 1927-39, 1943-61, 1971-76.)

United Arab Republic, Statistical Department (1960) Preliminary Results of the 1960 Census of Population. Cairo: Government Printing Offices. (In Arabic.)

United Arab Republic, Department of Statistics and Census (1962-1963) 1960 Census of Population (2 vols.). Cairo: Government Printing Offices (In Arabic.)

United Arab Republic, Supreme Council for Family Planning (1971) Demographic Pictures of the U.A.R. Cairo.

United Nations (1967-1979) Demographic Yearbook (for all years 1966-1978). New York: United Nations.

United Nations (1977) World Population Prospects as Assessed in 1973. Unpublished tabulations. New York.

United Nations (1979) Population and Vital Statistics Report: Data Available as of 1 April 1979.

Statistical Papers. Series A, Vol. XXXI, No. 3. New York: United Nations. (More recent issues through Vol. XXXIII, No. 3, 1981 also published.)

United Nations, Economic Commission for Western Asia (1978) Demographic and Related Socio-Economic Data Sheets for Countries of the Economic Commission for Western Asia. Beirut: Economic Commission for Western Asia.

U.A.R. Idarat al-Ihsa'at al-Ijtima 'riyah (Administration of Social Statistics) (n.d.) Al kitab al sanawy lil Ihsa'at a-Ijtima 'riyah (Yearbook of social statistics).

Valaoras, V. G., et al. (1972) Population Analysis of Egypt (1935-1970). Occasional Paper No. 1. Cairo: Cairo Demographic Center.

Vaidyanathan, K. E. (1972) Some approaches to the measurement of population change in Egypt. The Egyptian Population and Family Planning Review 5(2):167-175.

Vaidyanathan, K. E. (1978) The Egyptian study to measure vital rates: some estimates by dual collection. Pp. 104-112 in K. J. Krotki, ed., Developments in Dual System Estimation of Population Size and Growth. Edmonton: University of Alberta Press.

Vallin, Jacques (1970) Les Populations de l'Afrique au Nord du Sahara. Population 25(6):1212-1234.

Vukovich, Gyorgy (1966) Egyes arab orszagok termekenysegi es halandosagi szinvonalanak becslese (Estimation of fertility and mortality levels of some Arab countries). Demografia (Budapest) 9(2):162-177. (Russian and English summaries and table headings.)

Way, Peter O. (1979) Demographic and socioeconomic tables for Egypt with a discussion of vital registration. Mimeo. International Demographic Data Center, Population Division, U.S. Bureau of the Census. Washington, D.C.

Zachariah, K. C. (1970) The demographic measures of the Arab countries: a comparative analysis. Pp. 279-326 in Demographic Measures and Population Growth in Arab Countries. Research Monograph Series, No. 1. Cairo: Cairo Demographic Center.